Ecological Studies on Soil Insects of Some Selected Sites of Aligarh

ABSTRACT

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BY

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ABSTRACT

of the doctoral thesis entitled

"Ecological studies on soil insects of some selected sites of Aligarh"

by

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The soil, besides offering support to the vegetation also provides a natural abode for the meso and micro organism. The top soil is covered with the end product of the physical and chemical transformations called humus. This humus supports a variety of mesofauna. Soil is usually viewed simply as a medium for growing plants. However, in addition to providing a mechanical support for plants, soil enables the storage of water and organic matter, releases elements of biological and pedological importance. Soil organisms exert a major control over many soil processes through their effects on the decomposition of dead organic materials, nutrient cycling, the modification and transport of soil materials and the formation & maintenance of soil structure. Soil organisms also constitute an important resource for the sustainable management of agricultural ecosystems and their durability. A biologically healthy soil harbours a multitude of different organisms, such as bacteria, fungi, amoebae, paramecia, springtails, mites, insect larvae, ants, termites and ground beetles. Most are helpful to plants enhancing the availability of nutrients and producing chemicals that stimulate plant growth. A healthy soil produces healthy crops with minimal amounts of external inputs and few to no adverse ecological effects. It has favourable biological, physical and chemical properties. The life in soil has attracted the attention of ecologists thus, causing the origin of new discipline natural science known as Pedobiology. It has been developing towards maturity slowly but steadily.

The arthropods which are microscopic, measure 0.2mm - 15mm in length, creep on and inside the soil are called soil insect. They belong to two major groups; Apterygote (wingless insects like collembolans, diplurans, proturans etc) and Pterygote (winged insects like coleopterans, isopterans, dipterans, hymenopterans etc.). Soil microarthropods play an important role in the flow of energy and cycling of nutrients both at the herbivore and decomposer levels in humid to semiarid regions of earth. As with other organisms, the magnitude of their ecological role is related to their population density and biomass. They influence vital ecosystem processes, such as decomposition and nutrient mineralization. It is widely emphasized that various soil fauna, including microarthropods not only influence vitally important ecosystem processes, such as decomposition of organic matter and nutrient mineralization, but also stimulate plant growth.

A perusal of literature reveals that despite tremendous significance of this vitally important aspect of biological science, the studies on this aspect are not too many. Even in India, such studies are few and there is glaring paucity of information on this aspect particularly in the northern part of the country, which is quite diverse in climate change and faunal variety. The city Aligarh is located in western part of Uttar Pradesh with a regular climate cycle consisting of three different seasons characterized with extreme winter and summer followed by heavy rainfall during monsoon months. The temperature ranges from as low as 2-3°C in winter to touch the highest often reaching up to 46-48°C during summer months. Such widely varying climate conditions provide a variety of ecological niche to the soil dwelling organisms. The documented literature reveals that no systematic and detailed study has been carried out on the microarthropods population dynamics and their interrelationship with various factors in this region having divergent climatic conditions. In view of the agroforestry management, the role of these soil dwelling animals in general and microarthropods in particular have to be evaluated in context with the mineral cycling in the soil sub-ecosystem.

Therefore, the main objectives of our study were; (i) to find out the qualitative and quantitative account of soil dwelling insects and mites from the chosen sites, (ii) to measure the effects of various edaphic factors on the population and distributional patterns of insects and mites of Aligarh with respect to the information so far available, (iii) to study the correlation of various edaphic factors (Physical and Chemical) with the seasonal population dynamics of soil insects and (iv) to study the synecological interaction between the different groups of soil insects and mites forming a community. Attempts have also been made to verify by means of statistical analysis and finally to make a generalization as to the probable causes of population fluctuation by taking into account the results of the earlier as well as contemporary ecological researches on soil insects and mites along with those presented in the thesis.

There were four sites for study. Mango Orchards, Teak Plantation, Uncultivated Land and Wheat Field in which we studied the population dynamics of soil insects and their relation with physico-chemical factors like rainfall temperature, moisture, pH, organic matter, available nitrogen, phosphate, potassium. Mango Orchards is situated near the university health centre, there are approximate 50 trees and their soil is manageable soil. Teak Plantation is completely undisturbed teak community. This type of soil management practices will have an influence on the population dynamics of soil insects. The site of unarable field is situated at Zakir Bagh behind the faculty of Arts, A. M. U. surrounded by very few trees and rarely grazed by animals. This is no tillage site and the only sewage water flows from around into this field. This type of soil will have an influence on the population of soil insects. Wheat Field is located near the university Botanical garden (Formally University Fort) which has an interesting topography; this is also surrounding by very few trees and rarely grazed by animals. It is used for growing vegetable, wheat etc. through out the year; as a result it is under manual tillage as well as mechanical tillage and use of pesticides along with cow dung manure. This type of soil management practices will have an influence on the population dynamics of soil insects.

We observed in the case of litter population that the teak plantation area remains shaded throughout the year: the leaves of the teak *Tectona grandis* are thick and broad so they cover the area and do not allow enough sunlight to penetrate through except in the months of December to February. The absence of sunlight does not allow the growth of grasses even during monsoon months. Leaves, though thick and broad, do not form a substantial litter cover over the soil surface, because the litter is picked up or broomed by the inhabitants as this site is in the university campus. The leaves of Mango trees are heavy in weight but smaller in size. The leaf litter cover formed on the orchard floor was not very thick and during the months of March to September the litter cover was almost absent. As a result the population of the decomposer community, the Collembola was very poor, but the Acari mainly the Prostigmata mites were present in good numbers.The pterygote population was only represented by order Diptera, Coleoptera and few Hymenopterans at both the sites (Mango Orchards and Teak Plantation).

The litter supported an array of mesofaunal organisms and the total number of insects and mites showed an irregular trend of seasonal fluctuation with mostly peaks in monsoon

months. The acarina population in the litter was rich as compared to the collembolan population. The pterygote fauna was represented by good population of Dipteran adults, Coleopteran adults and larvae both the other members of order Isoptera, Pscoptera, Lepidoptera were in negligible amount. There exists a competitive interaction among plants and the soil fauna, but functional dissimilarity of the soil microarthropods have a great effect on the leaf litter mass loss and soil respiration. These observations support our collection of soil microarthropods but as these organisms play a vital role in decomposition by fragmenting leaf litter and adding vital nutrients to the soil their numerical count is equally important. Litter decomposition is an important ecosystem process that makes nutrients available for plant growth. This process is controlled by three types of interacting factors: the physico – chemical environment, the substrate quality, and the biota. Factors of the physico – chemical environment including climate and soil parameters determine the soil conditions for the process of decomposition. The substrate quality is mainly determined by the quality and type of the litter, and the chemistry of the litter, but it is only a predictor of variations in decay rate on local scale. Thirdly the biota which is considered to be most important factor in the decomposition process for any one leaf type under favourable conditions. In the present study the amount of litter at the sites *viz* the Mango orchard and Teak plantation was negligible in the Mango orchard and thick in the Teak plantation.

On comparing the litter population of the two sites, it is clear to some extent that the microarthropods are present in substantial amount with Acari being most abundant. The soil biodiversity is essential for the soil health and fertility and also for the plant growth; and the soil diversity is directly associated with the litter diversity and the litter itself, because the soil fauna decomposes the litter and in turn recycles nutrients to the soil ecosystem. The loss in biodiversity raises several questions, and one of major consequence of decreasing diversity is associated changes in ecosystem functioning because ecosystem processes depend on the presence of a specific number of functional groups, species and organisms. The ratio of numerical abundance values of collembolan and Mites shows that Mites are numerically greater than the collembolans. Similar results had been reported from other places of India.

The population of soil microarthropods was also studied in the mineral soil at 5 cm and 10 cm depth from all the four investigating sites. The populations of the soil microarthropods

were higher at 5 cm depth than at 10cm depth with fluctuating peaks in monsoon months. The mineral soil population at Mango Orchard Teak Plantation was slightly different in the group diversity as the Teak Plantation is a disturbed site. The population of order – Collembola was higher in Teak Plantation than in Mango Orchard with a winter minima. The occurrence of such a population dynamics is strongly correlated to the human interference and the presence of tree shade which restricts the process of evaporation and maintains the soil moisture content. The presence of few nematodes, earthworms and good numbers of termites in the upper layers of soil suggest that nematodes being the clearing agents, earthworms determine the vertical repartition depth in soils and termites form galleries in the compact soil for the circulation of water air and other organisms.

In the case of Unarable Land; this site was an unarable patch of land with undulating surface and experienced much human and cattle interference. All the Pterygote orders were nicely reported by both adult and larval forms with a monsoon peak. Order Isoptera outnumbered the other members of the soil community both at 5 cm and 10 cm depths. The Apterygote showed interesting results with order Collembola family: Poduridae having maximum number in January, February and March and sudden decline in monsoon months where as the acari was in good number throughout investigation period at both the depths. The populations of all the groups of soil microarthropods at this site show an interesting pattern. There were numerous Coleopteran larval forms but the Isopterans outnumbered every order, both the depth 5 cm and 10 cm. This observation is in conformity with the observations of workers on Coleoptera in general. The Carabide beetles require vegetational cover to protect themselves from adverse atmospheric conditions as this site was devoid of tree shade or any type of vegetation cover, the population of Carabidae larva was less at 5 cm depth and very less at 10 cm depth. The population of termites was significantly high as compared to other groups/orders. The order was represented by all the five families but family Poduridae and Isotomidae showed remarkable peaks in the months of January, February and March, consecutively for two years and very meager population in rest of the months at 5 cm and 10 cm respectively. The probable reasons for such as observation could be abiotic edaphic factors as well as some biotic factors.

In the case of Wheat Field; experimental site was an agricultural field where wheat was the only crop harvested and the rest of the year the field is left barren without any cultivation. For wheat cultivation the ploughing was done with the help of tractors, and then during cropping light tillage was done along with the use of chemical and organic fertilizers. Pesticides and insecticides were also sprayed before harvesting. The harvesting period also lasted for December to April months. The ready crop was left in the field for quite some time. After that the field was left vacant till the next sowing season. Now this character of the experimental site had a profound effect on the below ground faunal composition and their population dynamics. The population of soil microarthropods collected from the two different depths (5 cm, 10 cm) is different in quantity and quality. The Dipteran adults were more in 5 cm depth than in 10 cm, whereas their larval forms were more at 10 cm depth. Coleoptera were same at the depths, Hymenopteran adults were collected in large number at 5 cm and were absent in 10 cm. Lepidoptera was another important order which was represented by larval forms in good number at 5 cm. The collembolans were very few in number at both the depths in 2008-09, but in 2009-10 all the families were present though in few numbers. Similar was the case of Acarina population though the number was good.

The population of all the microarthropods when subjected to statistical analysis showed a positive correlation with soil moisture content and organic carbon. Atmospheric temperature and soil temperature had a significant impact on the population of soil microarthropods of all the working sites. It is therefore, concluded that the population fluctuation was irregular in most of the species with only one monsoon peak in all the working sites. Vertical distribution studies showed aggregation of population in the litter and upper most layer of the soil. The difference in the abundance and the seasonal fluctuation in the population of various groups are correlated with edaphic factors, which along with the topographical differences in the sites have a direct or indirect effect on the population of soil microarthropods.

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Certificate

*I certify that the work presented in this thesis entitled **"Ecological studies on soil insects of some selected sites of Aligarh"** has been carried out by **Mr. Mohammad Ilyas** under my supervision and is suitable for the award of the **Ph.D. Degree** in **Zoology** of Aligarh Muslim University, Aligarh.*

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Dedicated

To

My Parents

CONTENTS

Acknowledgement

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"All Praises are for Allah"

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Ilyas

Mohammad Ilyas

Introduction

INTRODUCTION

Soil and its ecological importance

The soil, besides offering support to the vegetation also provides a natural abode for the meso and micro organism. The top soil is covered with the end product of the physical and chemical transformations called humus. This humus supports a variety of mesofauna.

Soil is usually viewed simply as a medium for growing plants. However, in addition to providing a mechanical support for plants, soil enables the storage of water and organic matter, releases elements of biological and pedological importance. Soil organisms exert a major control over many soil processes through their effects on the decomposition of dead organic materials, nutrient cycling, the modification and transport of soil materials and the formation & maintenance of soil structure. Soil organisms also constitute an important resource for the sustainable management of agricultural ecosystems and their durability. A biologically healthy soil harbours a multitude of different organisms, such as bacteria, fungi, amoebae, paramecia, springtails, mites, insect larvae, ants, termites and ground beetles. Most are helpful to plants enhancing the availability of nutrients and producing chemicals that stimulate plant growth. A healthy soil produces healthy crops with minimal amounts of external inputs and few to no adverse ecological effects. It has favourable biological, physical and chemical properties. The life in soil has attracted the attention of ecologists thus, causing the origin of new discipline natural science known as Pedobiology. It has been developing towards maturity slowly but steadily.

Ecological role of soil insects

The arthropods which are microscopic, measure 0.2mm - 15mm in length, creep on and inside the soil are called soil insect. They belong to two major groups; Apterygote (wingless insects like collembolans, diplurans, proturans etc) and Pterygote (winged insects like coleopterans, isopterans, dipterans, hymenopterans etc.). Soil microarthropods play an important role in the flow of energy and cycling of nutrients both at the herbivore and decomposer levels in humid to semiarid regions of earth. As with other organisms, the magnitude of their ecological role is related to their population density and biomass. They influence vital ecosystem processes, such as decomposition and nutrient mineralization. It is widely emphasized that various soil fauna, including microarthropods, can not, only influence vitally important ecosystem processes, such as decomposition of organic matter and nutrient mineralization, but also stimulate plant growth (Verhoef and Brussard 1990, Setala and Huhta 1991). The importance of the role and function of soil animals were recognized in the soil formation and litter decomposition (Bal 1982). Decomposition of plant litter has been studied in various locations from arctic to tropical regions. These detailed was introduced by Dicklson and Pugh (1974). On the decomposition of leaf litter in the tropical forest region was studied by Anderson et al (1983), Matsumoto et al (1999) and Niswati et al (1998) for mixed leaf litter. The effects of soil fauna in these systems on decomposition rates, nutrient regeneration and soil structure have been well documented.

The activity of soil dwelling animals is very significant for the fertility of soil. Fertile soils is that soil which provides essential nutrients for crops, plant growth, support a diverse and active biotic community, exhibit a typical soil structure and allow for an undisturbed decomposition. Soil microarthropods are represented by major groups such as the mites (Acari) and springtrials (Collembola), which together account for 90% of the total microarthropods in most soil system. Microarthropods being the dominant group of soil fauna in boreal soils (Peterson et al 1998), have both indirect effects on these processes through interactions with other soil organisms, especially with microbes, and direct effects through fragmentation of litter and production of nutrient rich excreta (Seasledt 1984, Moore et al 1988). Hence soil communities are among the most diverse component of terestrial ecosystem (Giller 1996). There are evidences, showing that soil and their communities are influenced by activities and the biodiversity of soil is at least in some areas.

However, in India, such studies are few and there is glaring paucity of information on this aspect in the northern part of the country, which is quite rich in extensive climate and faunal biodiversity. Aligarh is located in western part of Uttar Pradesh with a fluctuating climate consisting of three different seasons characterized with extreme winter and summer followed by heavy rainfall during monsoon months. The temperature ranges from as low 2-3°C in winter to touch the highest often reaching up to 46-48°C. Such widely verifying climate conditions provide a variety of ecological niche to the soil dwelling organisms. The documented literature reveals that no systematic and detailed study has been carried out on the microarthropods population dynamics and their interrelationship with various factors in this region having divergent climatic conditions. In view of the agroforestry management, the role of these soil dwelling animals in general and microarthropods in particular have to be evaluated in context with the mineral cycling in the soil sub-ecosystem.

In the present study, the role of soil insect on the soil ecosystem under different land use areas of Aligarh, Uttar Pradesh, India. In the present era this particular discourse has evoked a considerable revival of interest among Pedobiologists. As a result, there is a considerable accumulation of literature concerned with the auteecological and synecological studies of soil arthropods from different parts of the world.

In early eighties, Joose (1981) studied the population dynamics of Collembola based on the study of surface dwelling species in the light of their life history, availability of moisture and physiological efficiency. Mallow et al (1985) found that the agricultural practices such as ploughing, tilling and weedicide spray change the structure of soil animal population and also the soil faunal composition. Joose (1981) also found that nitrogen is the single most limiting factor controlling litter decomposition and the overall decomposition is dependent on the presence of microarthropods. Fratello et al (1989) observed that irrigation strongly influences the effects of organic and mineral fertilizers on microarthropods population densities. Soil microarthropods are among the soil faunal diversity in nearly all agricultural soils (Crossley et al 1992) and their population affected by human invention and the toxic affects of the insecticides and pesticides. Studies on the soil ecology in relation to various aspects of biology soil insects attracted the interest of scientific community since late twenties. Significant contributions were made from time to time giving rise to more indepth and focused studies due to refinement in analytical tools.

Doran and Safely (1997) defined soil health as a living system that has the capacity to sustain biological productivity; promote the quality of air and water environments; and maintain plant, animal and human health. Soil microfauna are implicated in a number of soil processes such as decomposition of organic matter, nutrient mineralization, microflora regulation (including plant pathogens), decomposition of agricultural chemicals and improvement of soil structure (Gupta and Yeates 1997). Soil mesofauna (mites, millipedes and collembolans; referred to as microarthropods by some authors) are also thought to be involved in processing organic matter and augmenting processes involved in soil structure (van Straalen 1997).

Because soil mesofauna are still relatively sedentary, they do reflect the conditions of the soil habitat more than more mobile macrofauna. Mesofauna are abundant in agricultural soils, but much more needs to be learned about their contribution to soil processes (Crossley et al 1992). It has been reported that they are sensitive to agricultural chemical inputs and, as a result, may also have potential as biological indicators of chemical impact on the ecosystem (Koehler 1992). Soil macrofauna are sometimes involved in predation (spider and ants) of pest species; however, others tend to play a role similar to mesofauna in that their diet consists of primary and secondary consumers and they process organic matter and contribute to soil structure (van Straalen 1997, Doube and Schmidt 1997). Regulation of biota has been speculated to be the most important factor in the decomposition process for any one leaf type under favourable climate (Lavelle et al 1993). Recent studies have demonstrated that the soil fauna (mainly soil microarthropods) have a more profound effect on decay rate in wet tropical forests than in dry tropical, temperate and subalpine forests (Heneghan et al 1991, Gonazalez and Seasledt 2001). However the importance of soil fauna on decomposition has only been tested in two tropical wet forests (La Selva, Costa Rica and Luquillo Experimental forest, Puerto Rico) in central America (Gonazales and Seasledt 2001). Peterson et al (2004) have enumerated long term charges in microarthropod communities after introduction of livestock grazing in abandoned fields. Lindberg and Bengtsson (2005) described the spatial distribution and seasonal dynamics of these microorganisms. Yoshida and Hijii (2005) have shown that soil microarthropods respond sensitively to land management practices.

In ecological terms, we recognize that population cycles in insects are at least partially under the influence of a process known as regulation. Regulation describes the way in which a populations abundance varies through time as a decrease in population growth rate as population density increases (Agrawal, 2004). Declines in population growth rates with diversity can be manifested by: (i) increases in the rate (proportion) of mortality that the population suffers; (ii) decreases in birth rate; (iii) increases in emigration rates; decreases in immigration rates. When birth, death or movement rates vary proportionally with density, they have the potential to maintain an insect population around some equilibrium density.

If the density dependence occurs on a time delay, the population can overshoot this equilibrium, and exhibit cyclic behavior. Various biotic factors are known to be potentially regulatory. It is useful to separate such factors into those that act within a trophic level such as competition and those which act between trophic levels either from below via food supply or from above via the action of natural enemies such as predators, pathogens or parasitoids. These factors interact e.g. competition often acts via the amount of food available for individual insects. Food limitations via intra-specific competition may result in decreased fecundity or in increased migration. Keeping in view the great economic significance of this important group of soil organisms and its intimate relationship with soil ecology, there has been considerable interest to unravel the contribution of soil fauna to global biodiversity.

The selected study sites of Aligarh

There were four sites for study. Mango Orchards, Teak Plantation, uncultivated land and wheat crop field comparatively in which studied the population dynamics of soil insects and their relation with physico-chemical factors like rainfall temperature, moisture, pH, organic matter, Nitrate, Phosphate, Potash. Mango Orchards is situated near the university health centre, there are approximate 50 trees and their soil is manageable soil. Teak Plantation is completely undisturbed teak community. This type of soil management practices will have an influence on the population dynamics of soil insects. The site of unarable field is situated at Zakir bagh behind the faculty of Arts near the Masjid surrounded by very few trees and rarely grazed by animals. This is no tillage site and the only sewage water flow from the Masjid in this field. This type of soil will have an influence on the population of soil insects. Wheat crop field is located near the university Botanical garden (Formally University Fort) which has an interesting topography; this is also surrounding by very few trees and rarely grazed by animals. It is used for growing vegetable, wheat etc. through out the year; as a result it is under manual tillage as well as mechanical tillage and use of pesticides along with cow dung manure. This type of soil management practices will have an influence on the population dynamics of soil insects.

Objectives of the study

This has led the author to undertake the present project to fulfill the following man objectives.

1) *To find out the qualitative and quantitative account of soil dwelling insects and mites from the above sites.*

2) *To measure the effects of various edaphic factors like temperature, moisture, water content, vegetation, relative humidity, contents of organic carbon, Nitrate, Phosphate, pH on the population and distributional patterns of insects and mites of Aligarh in respect to which information so for available.*

3) *To study the correlation of various euedaphic factors (Physical and Chemical) with the seasonal population dynamics of soil insects.*

4) *To study the synecological interaction between the different groups of soil insects and mites forming a community. Attempts have also been made to verify by means of statistical analysis and finally to make a generalization as to the probable causes of population fluctuation by taking into account the results of the earlier as well as contemporary ecological researches on soil insects and mites along with those presented in this thesis.*

Review of Literature

REVIEW OF LITERATURE

The interrelation between living things and their environment on the earth attracted the human attention with the dawn of civilization.

The earliest attempt to study on soil fauna was made by Diem (1903) who surveyed the occurrence of soil fauna in the region of Alps Switzerland. Mc Atee (1907) successfully counted the soil fauna collected from forest floor and grass meadow. This work was followed by some useful observation in Pedobiology by Shelford (1913), Adams (1915), Thompson (1924), Jorjanson (1934) and Ford (1935). Cameron (1913) enlisted 163 different species from the soil at Manchester. Subsequently this author in 1917 extended his investigations on two types of grassland. He observed a marked variation in the faunal composition of the two areas and according to him; the variation was due to the prevalence of different environmental conditions.

Buckle (1921) was of the opinion that the distribution and density of soil fauna were more stable on grassland than on arable land and he observed that the soil fauna increased in both the areas with the growth of vegetation. Morris (1922) observed that there was an increase in the invertebrate population of an arable land when the farm manure was added to this piece of land. Edwards (1929) compared the invertebrate fauna comprising of Collembola, Symphyla, Diplopoda, Coleoptera and Diptera in the pasture areas as well as the area having an alluvial soil. Symphyla were found at a depth of 6-9 inches and several species of Collembola namely *Tullbergia* were also found at the same depth. He observed a striking difference in the qualitative and quantitative faunal composition from both the patches of land. According to him, the horizontal and vertical distributions were probably associated with: (I) situation and mechanical composition of soil which in turn determines the degree of moisture, aeration and temperature, (II) with the nature of flora which affected the density of surface turf means of shelter above ground as well influencing evaporation and (III) with the depth, particular food occurred specially for the carnivorous forms. He also observed the occurrence of injurious insects such as larvae of Elateridae and Curculionidae in all the four pasture area. These larvae were scarce in alluvial soil which was under partial cultivation.

Blacke (1931) studied the litter and soil inhabiting animal community of a deciduous forest. He took samples at three levels of forest; these were 0.6 metres (shrub level) and 11 meters (tree level) above forest floor and 10 cm (top soil below it). This work was a continuation of his earlier work published in the form of a monograph in 1926. He found *Tomocerus Onychiurus* and *Tipula* larvae along with some beetles belonging to family Cantheridae. He opined that during most of the period, the leaf stratum animals were the most numerous and determined the total population curve. He found lesser number of animals in the soil on the patch of land where herbs and shrubs were in abundance. He postulated his results as follows, "Population changes accompanied meteorological changes of the effects of such changes on the substratum, the numbers rose with high temperature and increased moisture and fall with the reverse". MacLagan (1932) made a comprehensive ecological study on the "Lucerne Flea" (*Sminthurus virdis lin*). He studied the effect of biotic environmental factors in detail upon the survival of this Collembola. The biotic factors that influenced the survival of *S. virdis* were insect predators in the form of two species of *Coccinella*, two species of *Philonthes*, and four species of family Staphylinidae were also the predators of Collembola. Carabidea like *Bembidon* sps. was also predating upon this Collembola besides beetles *S. virdis* was prone to the attack of Hemipterans like *Anthicorris lygus* and the *Dermptera forficula*. *S. virdis* also faced a threat on its survival from a number of species of spiders. The edaphic factors like temperature, moisture, hydrogen ion concentration, had a pronounced effect on the growth rate, development and fecundity. Besides these, the type of soil also had an effect on these vital processes. He concluded that the actual facts appeared to be the population increases in natural environment is seriously handicapped on account of diverse physiological assemblage of the individual and the fact that organisms flourish to the extent they do, is not due to much to their adaptation to the environment as to their increase in-spite of it, on account of enormous reproductive potential with which every creature is endowed. Ford (1935) compared the animal population of the soil and vegetation of ridge traversing a meadow at certain periods of the year and was able to collect the soil organisms upto the level of 263.8 million individuals per acre in the surface vegetation. He observed a rising population in December and declining population from January to May. According to him, the fluctuations were entirely due to variations in the population of collembolans. Frenzel (1936) made a comparative study of soil fauna of different habitats situated at elevations ranging from 110-2000 meters in Germany and inferred that soil moisture depending upon the structure mainly influenced the population fluctuation. The ecological plasticity of some of the soil organisms maximum population in October and early spring and minimum population on mid winter and mid summer were the focal points of his observations.

Ford (1937) extracted collembolans, Acarina, Staphylinides and spiders from grass tussocks with the aid of an improvised Tullgren funnel. In his opinion, moisture was of great importance for the existence of these fauna and the drying up and wetting of different regions of tussocks caused migration of certain species within them. A fluctuation of the population with an increase in November and December, early February and late February with the intervening minimum was shown to characterize the Collembola and Acarina. He elucidated that the February minima was in correspondence with the period of high evaporation rate which destroyed the tussocks structure, so, in his opinion the period of cold dry weather created a very adverse condition for the survival of collembolans and Acarina. Campwell (1937) studied the temperature and moisture preference of wireworm larvea. Most of them were located in a temperate zone of 8-140°F temperature. With an increase in temperature the wireworm migrated out of the hot end and became active at the cold end. Similarly, he found that the soil containing 3-4% moisture was too dry and it caused migration of the wireworm larvae towards the moistured soil. Migrations were also caused by the presence or absence of the food.

Melinchenko (1938) observed the periodic appearance of *Isotoma palustris*, *I. virdis* during winter months, he found that their numbers increase in the early hours of the day (8 am) and gradually decrease until 6.30 pm in his opinion, the temperature of the air reflected in the layer of snow apparently regulated the movements of the animals under phototropism. If the temperature of air was below requisite minimum, the individuals returned to the ground, if that of the air and strata of snow was favorable (probably about $\pm$ 0.1 to $\pm$ 0.2°C), the collembolans rose to the surface of snow. The optimal humidity according to him varied between 96-100%. Baweja (1939) studied the population dynamics of soil insects belonging to the orders Collembola, Coleoptera, Hemiptera, Hymenoptera and Diptera. He studied the phenomenon of recolonization of these insects after sterilization of plots under study. In controlled plots, the mean population varied from 61.2-67.6 million and in the sterilized plots, the population was from 98.2-111.8 million per acre. The proportion of insects to other invertebrates such as Myriapoda, Arachnids and Oligochaetes was raised from 2% in the control to 20% in certain sterilized plots. The peak of the population was observed in late autumn which was caused by a sudden increase in the numbers of collembolans. The decrease in the number of collembolans brought down the population of soil insects. Decreasing temperature between 55°F and 45°F was found to be optimum for the collembolans. According to him, the insects require seven months to recolonize sterilized plots. Glasgow (1939) made a comprehensive study of subterranean soil fauna. He observed that below the earth surface there is a region of perpetual darkness inhabited by a community of sluggish white blind animals whose modification recalled those of the cave forms. Some are infact recorded as cave forms (*Onychiurus armatus, O. ambulans, Tulibergia krausbauri, T. quadrispina*). The other truly subterranean fauna consists of Symphyla, four species of Onychiuridae, Pauropoda and Protura. Under wet conditions, the distribution of *O. armatus* is positively correlated with soil and moisture under dry conditions while *O ambulans* is positively correlated with moisture and negatively with the ignition loss of the soil. The correlation did not account for the uneven distribution of the animals. He extracted the animals by Ladell's Floatation Method. He concluded his studies that the vertical distribution of each species was different with the note that each species exhibited positive partial correlation with soil moisture and temperature, except in the case of *Onychiurus ambulans* which is independent of temperature and *Tullbergia quadrispina* which is not significantly correlated with moisture and temperature. As these factors were themselves negatively correlated, moreover, their effects cancelled each other out. Population fluctuation cannot be with certainty attributed to either. The population of both species of *Onychiurus* had a winter maxima. The population was prone to the effects of freezing and flooding.

Jacot (1940) observed that the seasonal and daily movements of the soil animals were due chiefly to the variation to light and moisture. He strongly advocated that animals should not be classified primarily on the basis of dominants, subdominants etc. but rather according to food habits, life cycles and interrelations. Agrall (1941) while working on the temperature preference of different species of Collembola, found that the collembolans are endowed with a great plasticity of thermic tolerance as they could withstand a considerable range of temperature ranging from -4°C to -10°C as lower limit and the 35°C to 38°C as upper limit. He further observed that the collembolan population is dependent upon water content of the soil. Gisin (1943) showed that the occurrence of some of the species of collembolans which were sensitive to edaphological conditions could be used as reliable index for determining the nature of soil.

Hammer (1944), a legend in the ecological study of microarthropods, through her works on microflora in Greenland and Canada observed that the soil fauna were to some extent negatively correlated to the soil moisture and they could be decided into two communities.

a) Moisturephilic

b) Moisturephobic

Dowdy (1944) studied the influence of temperature on the vertical migration of soil invertebrates inhabiting different types of soil. He observed that in areas which had been greatly disturbed by man the reaction of the invertebrates to the temperature changes are different. The soil invertebrates moved deeper into the soil during fall and winter and retuned closer to the surface the following spring. According to him, temperature was the main stimulus behind vertical movements. The range that he observed lied between 38°C and 45°C. He observed that many of these soil invertebrates were able to withstand freezing temperature without apparent injury.

In 1947, Strickland used floatation method of extraction for the first time for soil microarthropod from three undisturbed forest reserve and four Cacaco Estates. He was able to extract mites, termites, Nemetoceran fly larvae. According to him, the general soil fauna was considerably more abundant in the reserved forests than in the estates. The vegetation had a greater influence on the size of soil inhabiting insect population than the soil type. Although, the latter influenced the occurrence of other arthropod groups. In all localities, he found that acarina were the predominant animals in the soil and the litter. He observed a decrease in population of soil insects along with the depth and he found that these insects did not migrate deeper than 7 inches.

Two years later, he extracted the soil microarthropods with the aid of Tullgren funnel. This time he tried to compare the population of soil microarthropods of open Savanna land with that of an open Cacaco field. In both the plots, he observed that the Acarina and Collembola migrated downwardly as the moisture of the soil depleted during dry season. He further noticed that there was a considerable difference in the qualitative population, present in the plots in-spite of the fact that the nature of the soil being the same. He attributed this difference due to the difference in vegetation in the two plots that he studied. Weisfogh (1948) observed a population maximum in autumn and population minima in the summer in cases of Mites and Collembola. He has also observed that the different life forms of Collembola were strictly limited to certain biostrata especially to certain range of moisture. Representative of rare species were important indicators. According to him, the number of Collembola changed very little within a year. Kunnelt (1950) layed stress on the possibility of effects of the concentration of electrolytes in the soil size and the pore space on the population of soil microarthropods.

Mac Fadyen (1952) made a comprehensive study on the study occurrence of soil arthropods at Cothil near Oxford. He observed that microscopic vegetation had a great influence on the fauna but little effect on its species composition. The majority of species did not exhibit greater variation in the samples taken from near and distant parts of the area indicating a very uniform distribution within each plant type. The population of the fauna was largely confined to the upper 5 cm of the soil but in the winter some species penetrated further into the soil. The author observed a regular seasonal difference in population size as shown by most species, they involved an August minima and a February maxima, there were also lesser maxima for some species in December to May. There was relatively little variation in the species composition throughout the year. During his studies the author was able to collect large number of Oribatid, collembolans, Thysanoptera, Coleoptera adult and larvae and dipteran larvae. The population of microarthropod was prone to the effect of accidental fire. Salt (1952) made a useful observation on the arthropod population of the soil in some East African pastures. He used floatation methods developed by him and Hollick (Salt and Hollick 1944). He was able to extract collembolans, thysanopteran, Isoptera, coleopteran larvae, lepidopteran larvae, Symphyla, Chilopoda etc. He summarized his work as follows:

i) 11 soil samples from pastures yielded a population of 5456.2 arthropods per square meter in the top 6 inches of the soil.

ii) 9 soil samples from Coffee and Cassava and fallow land gave collections representing population of 24423 arthropods per square meter in the 8 inches of the soil. In his opinion, the populations of these arthropods in soil were meager as compared to that of an English soil. The author opined that the paucity of humus in the tropics was the main factor resulting in a smaller population of arthropod in the soil of East African countries.

Birch and Clerk (1953) observed that diversity of characterized soil fauna was attributed to-

(a) the density of different sorts of spaces in the soil
(b) heterogenecity of solid soil.

Bellinger (1954) emphasized that the most important factors determining habitat preference of many species of Collembola were soil moisture, amount and kind of organic matter present and nature of micro and macro flora. A species differed to an extent to which they penetrated through soil as opposed to superficial litter and humus. The author noted population maxima in spring and late summer, but at the same time he observed that each species had its own pattern of annual fluctuation which may differ in different areas. Causes of this fluctuation appeared to be complex, with temperature and rainfall.

In 1955, at Nottingham a symposium was held under Easter School and a galaxy of Pedobiologists participated. The proceeding of the symposium was complied in the form of a book "Soil Zoology". This was a great thrust to the ecological studies of soil inhabiting insects like termites, collembolans and mites. The symposium covered a wide spectrum dealing with the distribution of soil fauna along with the influence of the soil types. The new aspects of pedobiology such as effects of agricultural practices on soil fauna, the effect of DDT and BHC on the soil Collembola and Acarina were discussed. The book also deals with various methods of sampling and estimation and in the last pages of the book an attempt has been made to present a practical key to the orders and suborders of soil inhabiting insects. This was a great incentive to the workers in the field of Pedobiology.

In the same year, Haarlov (1955) made a study on the vertical distribution on collembolan and mites in relation to soil structure and found that vertical distribution of collembolan fauna was probably related to size and shape of soil cavities and scarcity of food materials. Raw (1956) was probably the first worker who succeeded in extracting the most agile and fragile group of insects the proturans with an aid of floatation method. He observed that the degree of aggregation appeared to be independent of population density. The distribution of these small insects according to him was associated with the condition induced by lining. Further, the abundance of proturans were correlated with exchangeable Ca^{++} and soil pH. We observed that the horizontal distribution of the collembolans and Acarina was not random. The fluctuation in the population of the collembolans may be attributed to the climatic conditions but the changes in the population of Oribatei were due to in part to the movements associated with their reproductive cycle. He further postulated that density of population of these microarthropods was significantly greater in the epigeal layer (0-3 inch) than in the deeper layer (3-9 inches). Wallwork (1959) investigated into the general biology of the forest soil mites in relation to selective decomposition of litter and formation of humus at Implake Michighan. He observed that the onset of the winter brought about numerical structural changes in the Mite population of litter and humus layer. The greater part of the fauna was found in the 7-10 cm of profile which was made up of distinct layer of litter and humus. During the summer, the number of mites was apparently four times as great as that of collembolans and at this time, slightly more than 50% of soil population occurred in litter. In winter a decrease in the number was observed in litter but the humus population was more than that of the summer. In litter, the largest population of adults occurred in the summer, while the peaks of juvenile were in winter. In humus, the population of adults continued to increase slowly through summer and later at the late winter.

Further he discussed the population changes of several commonly occurring oribatid mites to the following factors.

1) death
2) emergence of new forms
3) movements through the profile

Poole (1959) through an examination of the visible gut content of the Collembola showed that the largest species feed mainly on soil fungi whereas smaller forms appeared to feed directly on humus. He was of the opinion that the larger species of *Tomocerus longicornis* probably play an important role in the dispersal of soil fungi.

Granes (1960) was able to extract with the aid of Berlese funnel technique, soil arthropods representing five classes, fourteen orders and some seventy families among which ninety genera and seventy species were identified. Acarina, Collembola and Coleoptera were the dominant orders; this clearly indicated that fungal flora created a conducive habitat for soil organisms. Choudhury (1963) observation on the role of different ecological factors influencing the reproduction and development of different species of Collembola is an extension of his earlier work (1961, 62a, 62b). This comprehensive study is an important milestone in the pedobiological studies in India. Trehan (1945) laid stress on the role of various edaphological factors in conditioning the make up of collembolan population both qualitatively and quantitatively while ascertaining the effect of temperature on three species of *Onychiurus*, he found that the low temperature retarded the rate of development as some species of *Onychiurus* over winter either in the egg form or in nymphal stage. He observed that these collembolans are capable of withstanding the adverse atmospheric conditions created by cold and dry spells. Under favourable conditions, with the increase of temperature, there was rapid acceleration in the rate of growth and with this, the duration of each instar, total life span and preoviposition period shortened in duration.

Davis (1963) made a comparative study of Acarina and collembolan population of eight sites and he observed a seasonal variation in the population of microarthropods from a total of 114 species. According to him, the factors which made impact on the population of soil microarthropods, were the amount of organic content of the soil, but the most important factor which affected the seasonal variations was the moisture. Watenova (1964) observed that there is decrease in the population of springtails and mites with the depth of the soil. This decrease was attributed to the factors like the decrease of porosity, CO_2 evolution, carbon contents of the soil and amount of root in each horizon. Dowdy (1965) studied the population of microarthropod in an Oak-Hickort Community in Missouri. The number of mites average 296 per square feet of soil to a depth of 10 inches. Peaks in the mites population appeared in December and January with a temperature below freezing. The population was also high in March at a temperature of 8°C. The lowest peak appeared in November. The highest peak of Collembola appeared in January and February when 84% of the total number were collected. Only a small number of Collembola was collected in March.

In a Pine Community, 256 Mites and 197 Collembola were collected per square feet. Highest peak of population appeared in September with an air temperature 20° C and rainfall 6 inches. Peaks also appeared in July-December with low temperature and normal rainfall. In this community 69% of the mites were taken from litter and 29% from 0-2 inches level. 57% of the collembolans were taken from litter and 41% from 0-2 inches level. In the blue grass community the author observed a meagre population of mites and Collembola.

Ghilarov (1965) highlighted the role of soil fauna in Agro forestry. The activity of soil dwelling animals is very significant for the fertility of soil. In his opinion, destruction of plant debris, their penetration into soil, decay and humification and mixing with mineral particles proceeds due to the participation of the soil dwelling animals. He further stated activity of the soil organisms depends on environmental conditions and vice-versa. It leads to the changes in the environment. Hale (1966) observation on the population of Collembola in moorland is a clear reflection of Dowdy's work which lays stress on the fact that habitat has a pronounced effect on the life forms of Collembola. Hale, too, collected monthly soil samples from four vegetation type (lime stone grassland, alluvial grassland, Juncus grassland and Heather litter). In the low land area collembolans were found to be distributed non randomly and aggregation was found in all soil types study. Inter-specific aggregation occurred probably in the areas of food concentration. He observed that an adverse weather conditions caused a vertical migration as there was higher proportion of Collembola in a lower of the two layers in early summer and winter. The population diminished in the upper layer of the soil because of vertical migration but possibly as a result of differential morality or both. Seasonal variation in number, showed that in early summer and in early winter peak in total numbers of Collembola on lime stone grassland. Early summer peaks were also present in alluvial grassland and Heather litter. The four habitats had different population densities; lime stone grassland supported a higher average population density (52,920 per square meter) than alluvial grassland (48,920 per square meter). Heather litter (35,175 per square meter) and 20,930 per square meter in Juncus grassland.

Jenson and Corbin (1966) performed experiments to evaluate the microclimatic factors causing aggregation in animals and he selected *Isotoma virdis*, a Collembola and *Arion fasciatus*, a Pulmonate. They did not support the hypothesis that the temperature and relative humidity had any effect on the number of *I. virdis* and *Arion fasciatus*. However, they agree with the previous author like Glassgow (1939), that collembolans are sensitive to moisture and temperature. They postulated that a multiple factor system in which time of day passed, whether effects the formation of aggregation. Wood (1967) studied that the vertical distribution of Acari and Collembola from the four grassland soil from Yorkshire. He summarized his observation as follows: In a mil like Rendzine under Sesleria under *Festuca Agrostis* and two glycepofosolic earth under Nardus greatest density of Acarii and Collembola were found in upper 4 cm. The surface concentration of fauna was greater in podosolic brown earth (87% - 90%) of the total which had distinct LF and H layers over lying mineral horizons than in brown earth and the mil like Rendzine (76% - 79%) of the total were there was no surface accumulation of litter and where the horizon consisted of mixed mineral and organic matter the vertical distribution of individual was closely related to their life forms.

Luxton (1966) studied the variation in the densities of Mite population in landward and seaward areas. In his opinion, both the areas were basically homogenous with some evidence of microgradient in the density from sea to land. It was found that Mite numbers reached their peak in August and the fluctuations were attributed to the effect of soil moisture originating from precipitation and total effect. Moisture levels had a more significant effect in seaward plot. Kapetium (1968) studied the influence of several mechanical disturbances on the population of some epigeal forms inhabiting soil. Rosenzweig (1968) studied on the net primary productivity of terrestrial communities: prediction from climatological data. According to them, precipitation is related to primary productivity and has a strong effect on population dynamics of vertebrate populations. A thin, chitinous exoskeleton limits springtail distribution within ecosystems to sites with adequate moisture. Gill (1969) investigated whether litter determines the abundances of soil microarthropods. He observed that an increase or decrease in the amount of litter in the field produced a significant increase or decrease on the abundance of microarthropods during summer and winter and not during spring. The nutritional properties of litter were far less important. The litter had its effect on the microarthropods of soil and in turn affecting the soil faunal population.

Mc Millan (1969) studied the Acarine and collembolan population in two New Zealand pastures. He compared the seasonal variation in the density of collembolan and Acarine population of the two pastures. Through his analysis of total and partial coefficient correlation, he found that in majority of instances soil moisture and temperature did significantly influence population numbers. He found that, Acarii and collembolan population attained greatest number generally during autumn and winter, when temperature was decreasing. The pattern of seasonal periodicity was not uniform for all the constituent group of Collembola and Acarina. A comparative study of frequency and dominance of collembolan and Acarine species. revealed that *Isotomina thermophila* was the most dominant collembolan in plot A and ranking second in dominance in plot 3. *Oppia* spp. was the most dominant Acarine in both the plots. He concluded that in both the plots a significant association existed. Usher (1969) worked on some properties of the aggregations of soil arthropods: Collembola and explained that Collembola behaviour in presence of a predator generally considered individual reactions but no data are available on the reactions at the population level. Collembola populations are known to aggregate in space.

According to Kaptin and Groen (1970), *Tomocerus minor, Orchesella cicnta* and *Isotoma virdis* reacted differently to the same saturation deficit. The different species reacted differently to the same saturation deficit value with the humidity preference of the species in their natural habitats. In their opinion, desiccation stimulated Collembola to higher locomotory activity and finally let them to aggregate in optimal humidity condition. Christiansen (1970b) while making behavioural studies in Collembola, especially pertaining to general aggregation, selection of substrate, aggregation around food dispersal under different conditions observed that in the Entomobryoidae, the epigeic and trogolophilic forms showed larger aggregation than the trogolobitic forms. In reference to the substrate selection the species showed preference for wet or drier substrate. According to Belfield (1970) the population density of soil arthropod was greater in the shaded plots than in the unshaded plots. Choudhury and Roy (1970) studied the effects of soil condition on the collembolan population in the district of Jalpaiguri, West Bengal (India) and observed lack of identity among the collembolan population of the two plots though having more or less similar soil conditions. Mukherji and Singh (1970) studied the seasonal variation in the densities of Collembola, Acarina, Diplura, Symphyla, Pauropoda, Palpigradi and Pseudoscorpions in a rose garden at Varanasi. They found that there existed a certain correlation between the moisture content, temperature and the population dynamics of soil microarthropods, when both, the temperature and soil moisture contents are reasonably high. They observed a narrow range of variation in the case of pH and organic matter of the soil. According to them, it was difficult to interpret any correlation with these soil factors and population of soil arthropods. Erasmus and Ryke (1970) worked on the soil measofauna associate with Eragrostis curvula (Schrad) ness and reported an increase in the density of microarthropods as soil moisture conditions increased. However, the fact that correlation between moisture content and mite numbers at the cassava plot was not significant implies that the disturbances at the cassava plot as a result of cultivation probably introduced other factors which influenced mite populations. These factors must have been superimposed on the existing factors under forest conditions.

After 1953 in 1970 was another major breakthrough in Pedobiology a book entitled "The Ecology of Soil Animals" by publication of Wallwork. This book is a comprehensive and systematic account which deals in detail, the soil environment, soil forming processes and the soil type, classification of the soil fauna, regulation of population size, character of the soil community and the functioning of the soil community. This was a great thrust towards the ecological study of soil fauna and was a source of inspiration for new entrants in the arena of Pedobiology.

Choudhury and Roy (1971a) observed that the population of collembolans reached the maxima in Nov-Jan in an uncultivated plot of West Bengal. These maxima had a positive correlation with organic carbon, $CaCO_3$ average particle size, but negatively correlated with moisture. In a separate attempt Choudhury and Roy (1971b) studied the vertical distribution and seasonal fluctuation of the *Lepidocyrtus*_sp. They observed a monsoon peak in July and winter peak in December in West Bengal. It has also been shown that soil inhabiting acarina could tolerate a minimum temperature upto 18°C and during this period there was an increase in the population; Oswald (1971). Wood (1971) worked on The distribution and abundance of *Folsomides deserticola* Wood (Collembola: Isotomidae) and other microarthropods in arid and semi-arid soils in southern Australia, with a note on nematode populations and has found to be widespread in Australian desert soils; the remainder comprised, to a very large extent, individuals identified with the genus *Xenylla.* Lee and Wood (1971a) studied on physical and chemical effects on soils of some Australian termites and their pedological significance and stated that for Australian mound-building and subterranean termites there was a lowering of the pH compared with surrounding soil, but the differences were small. They also found in a few mounds that the pH was higher than the surrounding soil but, as before, not by a great margin. A decrease in pH is associated with the incorporation of organic-rich excreta while an increase is often correlated with an increase in calcium. Butcher et al (1971) studied on Bioecology of edaphic Collembola and Acarina and found that soil temperature accounts for 76 percent and 61 percent of the variation in mite numbers at the forest and cassava plots, respectively, and soil temperature was not as affected as moisture content by the new factors imposed upon the cassava plot because the negative correlations between this factor and mite numbers at both plots were significant. High soil temperatures have been reported to reduce or prevent egg-laying and cause mortality of the sperm of mites thereby leading to a decrease in the size of mite populations. Solhoy (1972) studied the invertebrate fauna of mountains in South Norway. He found that the fauna of the vegetation layer on the three sites namely – the dry meadow, wet meadow and lichen heath was dominated by Collembola and Acarii. During the draught period, in July/August a pronounced drop in population occurred on the dry meadow and lichen heath, while the population on the wet meadow was positively affected. The trends in the total number during the seasons were chiefly governed by the variations in these two groups. In the wet meadow the groups Hemiptere, Coleoptera, and on the dry Lepidoptera and Coleoptera. Thysanoptera showed an early summer peak in the dry meadow but a late summer peak in wet meadow. The number of other groups Hemiptera, Coleoptera was quite similar in July and September. It was interesting to note that the number of Hymenoptera and *Opilina* decreased from early summer towards the autumn and the trends were almost identical on both dry and wet meadow. In the dry and wet meadow, the number of Hemiptera and Diptera showed a decreasing trend towards autumn.

Choudhury and Roy (1972) in their comprehensive studies on the quantitative and qualitative composition of collembolan fauna of West Bengal in India gave a detailed account of their seasonal variations and distributional pattern of Collembola (both horizontal and vertical) in relation to various soil factors namely, moisture, organic carbon, nitrate, phosphate, calcium carbonate, hydrogen ion concentration, particle size and soil cover. According to them, the spectrum of Collembola was not very large and the collembolan fauna extracted, belonged to 25 genera of the families Entomobryoidae, Onychiuridae, Hypogastruridae, Nenuridae, Poduridae, Isotomidae and Sminthuridae. *Lepidocyrtus*, *Proisotima*, *Cyphoderus*, *Lobella* and *Isotomurus* were the dominant genera. The general form of population curve which they obtained seems to be determined by aforesaid three genera, members of which attained peak in July and August. The winter maxima were also obtained in some cases. They postulated that the rise in the population density was correlated with the soil factors like moisture, organic carbon, nitrate and phosphate. The particle size was also found to be significantly correlated with the population, at least, in some cases. They found majority of the individuals in the upper layers of the soil. Fujikawa (1972) compared the population of mites thriving on leaves without insecticides with that of the leaves with insecticides. In all 781 adult Oribatid mites representing 40 species were collected. 9 of the 40 sps were common to both with or without insecticide. Of the 9 species *Oppia* sp. was dominant. He further stressed that the fresh leaves taken from the trees were not conducive to the growth of the population of Oribatid mites in comparison with that of the litter in various stage of decomposition.

Ghilrov (1973) elucidated, "Soil tillage an agricultural utilization affects soil animals in various ways and are to a different degree dangerous to various taxa and various soil invertebrates accompanied by change in predominant species". He observed that many ecological groups/taxa were completely eliminated after tillage and other agricultural operations. Edward and Lofty (1973) while working on the influence of cultivation on the soil microarthropod population, observed that affects of ploughing more or less stimulated the conditions that normally prevailed in an arable land. Vlug and Borden (1973) observed the population density in water logged and burnt forest area was moderate indicating that neither of the two cause induced mortality. There was no seasonal fluctuation and no correlation of the density of population with soil moisture, hydrogen ion concentration and temperature. Zheleva's (1973) observations were in the line of above quoted works, according to the author, the deep cultivation of the soil was favorable for the species inhabiting deep soil layer. The cultivation of soil influenced the seasonal variations of Oribatid population of different spp. The use of fertilizers however, did not make any difference in the total number of Oribatids. Athias (1974) observed numerous fluctuations in the population of soil mites related to three environmental factors namely soil temperature, soil moisture and amount of litter. A dry warm soil supported highest mite densities. The increase in soil moisture did not affect the abundance. He found a positive correlation between the number of Oribatids and dry weigh of the litter. Other important factors that influenced the population density of mites were soil erosion and amount of the roots of the grass plant. Edward and Lofty (1974) while ascertaining the effects of organic manures and other factors on the invertebrate fauna of a grassland in a park observed that the total collembolan population remained little affected by the level of nitrogen. A slight increase in response to single dose of nitrogen was noticed, but the number of soil dwelling collembolan decreased much more than those living near the surface of the soil. In their opinion Collembola as a whole was influenced by the hydrogen ion concentration of the soil more than the mites.

Choudhury and Banerjee (1975) in their ecological investigation on the soil *meso and micro fauna* of uncultivated plots of West Bengal, India brought to light the following information-

1) Crystostigmate mites predominates in monsoon months (July – August) over other groups of mites such as Mesostigmata, Prostigmata and Astigmata as well as Collembola in the scale of population – abundance next come Collembola followed by Mesostigmata, Population of both Prostigmata and Astigmata mites were significantly low to both qualitative and quantitative composition.
2) Population size of both Acari and Collembola appeared to be dependent on the organic matter – microbes complex operating in soil.

In the same year Choudhury and Bhattacharya experimentally investigated the effects of temperature and humidity on the development and hatching of eggs of *Lobella mxillaris* Yosii (1966) under laboratory conditions. The results that obtained are summarized as follows:

1. There existed a direct relationship between development index and temperature – humidity complex.
2. Though the minimum incubation period was noted at 30°C and 100% RH at this temperature / humidity complex the egg mortality was high because of fungus infestation.
3. The rate of hatching was relatively low at 25°C with 90% RH.
4. Favourable range of humidity for development at all temperature gradient was between 95% and 100% RH.

5. Rate of mortality of developing embryo increased in low temperature combined with desiccation.
6. Decrease of humidity retarded the rate of development.

Singh and Pillai (1975) compared the population of soil microarthropod of banana field, a citus orchard, fodder field and fallow land. They found that population density of microarthropod ranged from 1697 to 20,376 per square meter. Acarii was the most dominant group of all the habitats ranging from 45.5-71.7% of the total fauna. Maximum number of Collembola was obtained from banana field where the soil moisture, organic content and calcium carbonate were high. Population density of Collembola in different habitats ranged from 11.9%-41.7%. A positive association was observed between the collembolan and oribatei and negative association between collembolan and Prostigmata. Quantitative composition of collembolan showed that some species were specific to particular habitats in their population build up. Collembola and Oribatei were dominant in soil with high organic matter content and Prostigmata predominated in the soil with lower organic matter. Tadros (1976) made an attempt to test the role of micro fauna in the decomposition of fresh organic matter, it was found that the organisms responsible for the process belongs to two phylum Arthropoda and Annelida, and three classes Arachnida Insecta and Oligochaeta. Arachnides reached a rate of (65.19%) followed by Insecta (33.36%) while the Annelida was the least infesting organism (0.68%). He observed that mesofauna preferred to live on leaves followed by roots and lastly stems. He concluded that the period needed for the decomposition of fresh healthy plant part into consideration, it appeared that the first period was more suitable for the soil fauna to work than the second one. Oribatei was a group of high infestation followed closely by Insecta. Knight (1976) compared the seasonal and microstratal dietary habits of two species of *Tomocerus*, that is *T. lamelliferus* and *T. falvescens* occurring in pine and mixed deciduous community. Three random samples of upper soil profile were taken from each ecosystem. In the case of *T. lamelliferus* it was found that in the litter, the micro-stratum of the pine community organic detritus material was consumed in significantly greater quantity than fungal material. But no statistically significant results were obtained from the data collected from deciduous area. Though, the deciduous humus population was larger than those recovered from the upper litter microstrata. There was a tendency for older members of *T. lamelliferu* with greater frequency in microstrata and each system investigated. In his opinion, feeding activity occurred more frequently in the litter microstrata, soil profile. The humus microstrata may serve as a convenient refuge for moulting activity when the organism would be more vulnerable for predation. Hiroshi (1976) studied the population density *of Folsomia octoculata* in a sub-alpine coniferous forest. The body size of the individual population ranged between 0.3mm - 0.6mm in length and the population is always composed of 2-3 generations. Breading period appeared to begin in mid July and cease in mid October. Population structure was seasonally different, but, stable year by year. The peak of growth rate was observed in August every year. The species was chosen by the author as it was a dominant Collembola in Shiga heights. The annual mean temperature of the area was 3.7°C with soil type was wet podosal.

Dean et al (1976) studied the effects of carbaryl on Mites, Collembola and Calosoma in an Oak type forest. The carbaryl was spread serially for the control of gypsy moth at the rate of one pound per acre. This treatment did not have a lasting significant effect on total mite population. The collembolan population was reduced in about six week and three months after treatment. This reduction was not apparent by the following spring. In their opinion, the insecticide had a short term effect on the mite and collembolan population. Wong et al (1977) observed that Collembola and Acarina were abundant in the soil which had higher contents of organic matter. Anderson (1977) studied on the organization of soil animal communities. According to him, a serious difficulty for understanding the diversity–ecosystem functioning relationship in decomposer invertebrates is that knowledge on the driving forces for the evolution of soil-animal diversity is poor. The packing of animal species in soil is exceptionally dense. In forest soil, hundreds of species and thousands of individuals are concentrated in the litter layer and the uppermost mineral-soil layer the size of a footprint. Both the diversity within and the diversity between trophic groups are high. Food relationships between soil-animal species are not well studied, but some evidence shows that most taxa are food generalists rather than specialists. Nosek (1977) studied the adaptations in Protura related to their soil life. According to him, the evolutionary adaptations in Protura are of not only physiological, ecological and morphological nature but genetic and geographical isolation as well as population genetics are of importance. Protura are well adapted to different life conditions existing in edaphic environment. Price and Benhan (1977) are of the opinion that population densities of microarthropods (Acarina, Collembola, Pscoptera, Pauropoda, Protura, Symphyla, coleopteran and dipteran larvae and Diplura) decreased gradually with the increasing depth. According to them, the sampling depth in the study area perhaps in all agricultural cultivation sites should extend atleast to the bottom of the tillage zone. As they found some of the taxa of microarthropod were abundant below the tillage zone. Hutson (1978) studied on Influence of pH, temperature and salinity on the fecundity and longevity of four species of Collembola. According to him long-term reduction in environmental pH may disrupt soil fauna. Changes in the structure of collembolan communities due to soil acidification have been observed in alpine grassland, where an alkalophilic species decreased and was replaced by an acidophilic species. This change not only involved mortality but also other factors such as fecundity and longevity. Muraleedharan and Prabhoo (1978) Collembola capable of selecting food, Collembola feed on fungi. Food relation between soil animal species is not well studied, but some evidence show that most texa are food generalists rather than specialists.

Bhattacharya and Roy Choudhury (1979) studied the population fluctuation of the soil microarthropod in a stretch of arable land of Shantiniketan in relation to some climatic and edaphic factors for two years. Soil microarthropods including two major groups, Cryptostigmata and Collembola, showed two peaks, a pronounced peak during post-monsoon period (September and October) and less pronounced peak in pre-monsoon period (May and June). Collembolan population have been found to have a significant positive correlation with a mean monthly RH, air temperature and with the moisture content of the soil, whereas mean monthly RH and moisture content of the soil had a significant positive correlation with Cryptostigmatid mites. Contrary to these, pH showed significant negative correlation with Cryptostigmatid, Collembola and with microarthropod population in general. Moisture content of the soil was considered to be the most important single factor responsible for the population fluctuation of microarthropod inhabiting soil. Bath (1980) found that the soil when treated with H_2SO_4 influenced different soil biological properties significantly. It caused a decrease in the rate of decomposition, the microorganism population. The composition of soil fauna population consists of Collembola, *Hypogastrura, Isotoma,* Mesostigmata, Astigmata, Prostigmata and Cryptostigmata changed. Hence, the total decrease of the activity remains prevalent ultimately decreased the soil fertility. The authors observed, that, "from our results it was not possible to conclude that changes in soil biological properties were entirely due to hydrogen ion (H) the acid was distributed as H_2SO_4. It can be excluded that the added SO_4 could have negative effect on soil organism. Qualitative and quantitative changes in the input of plant litter could also be the major factor. The ground and field vegetation were almost killed in acid treatment. It appears, however, that one cannot preclude that acidification may have marked influence on the processes in the below ground ecosystem and consequently, in a longer time perspective, on the whole terrestrial ecosystem".

Hole (1981) studied on the effect of animals on soil and summarized the activities of soil fauna which include: mounding, mixing, forming voids, forming and destroying peds; regulating soil erosion, plant and animals litter; assisting the movement of air and water in soil, and regulating nutrient cycling. These activities have long been recognized as having a significant role in soil formation. Josse (1981) studied the population dynamics of Collembola based upon the study of surface dwelling species like *orchesella* and *Tomocerus minor* in light of their life history, availability of moisture, physiological efficiency and behavioural methods to combat with desiccation. In this connection, their locomotory behavior and jumping mechanism were also taken into account. The author elucidated that reproduction and feeding were linked and starvation brought a cessation of reproduction and development. The author was of the view that the role in regulating the population size apparently depends on the nature of the environment. An unstable environment clearly less favourable for *T. minor* mainly because of density independent factor such as RH, in this case affects population number. The same habitat was found to be favourable for *O. cineta*. Humidity is important but acts indirectly on the number via mobility. In a more stable and favourable environment, biotic factors play a more direct role, a higher predation risk for *O. cineta* and specially stronger competition between two species. Josse (1981) while working on the ecological strategies and population regulation of Collembola in heterogeneous environments found that springtails are parthenogenetic; sexual maturity generally occurs at the sixth instar and oviposition generally occurs within 12–48 h after moulting at 21°C. Takeda (1981) studied on effects of shifting cultivation on the soil mesofauna with special reference to collembolan populations in the north-east Thailand. He documented the seasonal changes in abundance of Collembola in north-east Thailand. The population of Collembola abundances increased in the wet season and decreased in the dry season. William (1981) studied low temperature effects on microarthropods. Badejo (1982) has pointed that, there was an increase in the density of microarthropods as soil moisture content increases and more mites (acarina) are generally supported in the upper layers of fermentation and litter. A difference in arthropod population structure in the soils of forest and Jhum sites of North Eastern states was observed by Darlong and Alfred (1982). They further observed that firstly the population density was maximum in May and minimum in December from the upper soil layers. Secondly the population tended to decrease during dry and cold season. According to them, temperature and precipitation are of vital importance for soil fauna. The occurrence of high population during rainy season was due to the excessive moisture content in the soil and winter minima was due to desiccation of soil combined with low temperature. The Jhuming practice increase the pH of soil decreased its moisture holding capacity, which in turn caused loss of vegetation and increase soil temperature. It also reduced the soil organic matter and consequently the availability of food to the soil fauna.

Parker et al (1982) studied on the effects of subterranean termite removal on desert soil nitrogen and ephemeral flora (Gnathham-itermes tubiformans, Amitermes wheeleri) and measured an increase in soil nitrogen at the 0-2.5 and the 10-20 cm depths in the absence of termites. Hubta and Milkonen (1982) were able to extract 7 sps. of Entomobryoidae. The most abundant of these was *Lepidocyrstus*, which amounted to 10,000 sq.m. The authors classified the 7 sps. into three groups according to their population cycle. All 5 sps. belonging to genus *Entomobroya* and *Orchesella*. The over wintered adult gave rise to the generation that started hatching in June or to some extent at the end of May. In Lepidocyrtus, hatching took place early and small juvenile were always abundant in first half of May. Probably, the eggs laid in previous year continued to hatch after melting of the snow. Over wintered adults were also present in May and probably produced the second wave of juvenile. Finally *Tomocerus* reproduced continuously in several ways during summer so that population consisted of many age classes. The oldest animals die during winter and half grown individual of different sizes were found in spring. Their offspring started hatching in July. This study revealed that temperature regulated the reproduction of springtails. The other important factor was moisture. According to the authors, Entomobryoidae are highly capable of searching suitable microhabitats. Petersen and Luxton (1982) studied on a comparative analysis of soil fauna populations and their role in decomposition processes and reported that Collembola generally subjected to a heavy predation pressure because of their aggregative behaviour; nevertheless, they are found in very large number in soil and this puts the question if springtails have developed defence strategies against predators. Huther (1983) studied the impact of human interference on the collembolan population. The author selected three habitats to evaluate the effects on ground fauna by burning and cultivation. On the soil surface, collembolans were dominant as were the mites in the soil. The dominant collembolan group on surface was *Hypogastrura*, in the soil the blind Isotomides. One month after clearing the burn, the population density on the surface was higher than in the primeval forest but mites were now dominant and collembolans were completely absent from the soil. One year after the burning, the total arthropod population was similar to that of the primeval forest but the respective collembolan population showed distinct differences. In an orange plantation, the arthropods on the surface were much more abundant then in the forest including the Collembola but the mites were dominant. Rajagopal (1983) reviewed the earlier works on various aspects of the life of termites. His comprehensive review covers a wide spectrum including-

1. Classification
2. Distribution
3. Biology
4. Nest system
5. Architecture
6. Temperature and humidity relation
7. Population density

The population density and fluctuation in the cast composition within seasons vary with species to species. The optimum temperature requirements for *Heterotermis indicola* (Wasmann) was between 30-32°C. Mitra et al (1983) studied the effect of organic and inorganic fertilizers on a collembolan population. The authors are of the opinion that organic and inorganic fertilizers affect the number of Collembola favorably. Former exerting direct influence by providing food and later indirectly through the effect on the growth of plant and microorganism. The authors further stressed that rotation of crops with the application of fertilizers, increase the population of those species which were able to tolerate the rigoors of cultivation. It was further observed that the effects of various dosages of NPK during jute, paddy and wheat cultivations were reflected in their population dynamics. Long term use of chemical weedicides had a significant effect in reducing the population of Collembola as well as crop yield. During paddy cultivation, the effects of chemical weedicides, however, les pronounced presumably due to high degree of moisture and intermittent rains which diluted their effects.

Hagver (1984) performed experiments by adding calcium carbonate and dilute H_2SO_4 in the soil and observed the abundance of several species of Collembola in two out of three experiments. The total abundance of Collembola was *significantly reduced. The abundance of Protura increased in one experiment.* Reduced soil pH (mainly after application of water with pH 2-2.5) resulted a complex reaction pattern. Tamm (1984) work on the life of terrestrial arthropods living in flood prone areas, revealed that collembolans and Acarine undergo a stage of inactivity during submergence and their eggs hatch after the water recedes. Takeda (1984) showed that the birth and death rates of *Folsomia octoculata* are both temperature dependent in pine forests. In temperate forest soils, seasonal changes in population abundance reflect the birth and death processes of populations during the growth and reproductive period from spring to early winter and the mortality during the winter period. During the wet and dry seasons, recruitment occurred repeatedly and gave rise to an overlapping generation structure, and there was no evidence of aestivation during the dry seasons. Seastedt (1984) studied on the role of microarthropods in decomposition and mineralization processes. He found that abundances of soil arthropods were about 300,000 m^{-2} in temperate forest soils compared with 50,000 m^{-2} in tropical forest soils.

Mallow et al (1985) studied the effect of different management practices on the population dynamics of Acarina and Collembola in corn production system. His studies were directed towards the effect of ploughing and a weedicide Atrazine. He sampled the collembolans and mites from plots on which corn was grown. The soil was highly fertile with high moisture content. They compared their results with that of a grassland counter part. They found that Acarina and Collembola increased in June with maxima occurring in July for Acarina and in August for Collembola. The trends in the natural population level of these soil animals show a great deal of variation with respect to seasonal fluctuations. They observed an indirect effect of cultivation on the population dynamics in the form of a change in preexisting plant cover. Such an alteration of vegetation cover changed the structure of soil animal population within one horizon and soil type. The change in the vegetation cover also changed the quality of soil organic matter which in turn, affected the faunal composition. The authors concluded that after seven month of the treatment, there was no recovery of the level comparable to grassland for total Acarina as Prostigmata, Cryptostigmata began to recover after few months while Mesostigmata recovered just after three months. The quick recovery in Mesostigmata in general may be attributed to their predatory behaviour. Population of Collembola with an exception *Tullbergia granulata* began to recover after four months. Tamm (1986) studied the post fire effects on the succession of surface dwelling Collembola in an unburned forest. He recorded 50,000 individuals distributed under 44 species. The fire brought a drastic change in the habitat as it resulted in the carbonization of ground vegetation to a large degree thus causing destruction of raw humus of the top soil. The fire mortality of epizooic springtail was very high. Seven months after the fire, the individual Collembola captured in burnt area were reduced to 20% in April. However, just two months, the burnt population level coincided the control level and their means remained greater than the control during entire study period. The first most striking effect on Collembola was the long term change in the dominance structure, although, species diversity did not change conspicuously. After the burn, 10 of the 25 more numerous species were clearly and consistently reduced by the fire. These species were mainly surface dwellers. Three of them probably became extinct. The long term effect causing reduction in the collembolan population was that the fire induced changes in the habitat structure. The most abundant species in this area were numerous in both burnt and unburnt areas. The remaining 13 species were for more numerous in burnt area than in the controlled area. Most of the species preferred either open habitat without a wood stratum or more xeric condition. With the reappearance of the vegetation, there was an outbreak of collembolan pioneer species. The collembolan fauna of burnt area gradually approached but not recovered its pre-burnt condition within the study period. After five years of succession some of the species which were typically abundant after the burn, but only occasionally found on the un-burnt area still dominated the community in contrast to many other arthropod group, the succession of Collembola is not characterized by a species which immigrated to burnt area.

Mola et al (1987) studied the effects of weedicide atrazine on a species of Collembola under laboratory conditions. They compared the results of laboratory test with those obtained in field studies and confirmed that the field herbicide effect may be direct. In fields the atrazine causes cessation in the frequency of fecundity and thus affects reproduction. But this effect is a short term effect as the collembolans under study restored the breeding capacity after a month.

Takeda (1987) studied on dynamics and maintenance of Collembolan community structure in a forest soil system; they supposed density-dependent regulation to be the cause for the consistency of temporal organization patterns of the studied Collembolan community, yet without testing this hypothesis by formal analysis. House et al (1987) worked on herbicide effects on soil arthropod dynamics and wheat straw decomposition in North Carolina no-tillage agroecosystem. According to them, a decreased vegetation canopy can change the microclimate by affecting the temperature and moisture of soil. Anderson (1987) studied on interactions between invertebrates and microorganisms: noise or necessity for soil processes? According to him, the indirect effect of soil invertebrates on litter decomposition through litter fragmentation and modifications of the structure and activity of the microbial community considerably exceeds the direct effect via their own metabolism. Vance et al (1987) worked on an extraction method for measuring soil microbial biomass and C contents and they have summarized that intact sub samples of the collected soils were used to characterize complementary biochemical and microbial parameters. Intact sub samples for biological analysis were immediately stored at 4°C until analysis. Triplicate 15 g aliquots of intact soil were used to determine N microbial biomass (N-MB) and C microbial biomass (C-MB). C-MB and N-MB were determined by the fumigation-extraction method using alcohol-free chloroform. In both cases, MB was calculated as the difference in total C and N extracted in the fumigated and non-fumigated soil. Didden (1987) critically evaluated the suggestion by Usher (1976) that aggregation of soil microarthropods in favourable microhabitats can be caused by two factors – the location of food sources and the physical environment. The author performed a number of experiments and opined that food as a factor could be ruled out so were the temperature and humidity. So the author further stressed that the pore structure remains the only factor that influences the nature of environment. The compost soil with 7.18% macropores by volume have sufficient space to harbour, the collembolan though, the macropore were not interconnected. Thus the author inferred, that the animals disappeared readily into compost soil even though they were placed on the surface compacted by the press. This indicates that they need more space to live in the soil.

Cannon and Block (1988) stated the cold tolerance of microarthropods. In their study, all microarthropods appear to be freeze susceptible and they utilize varying levels of supercooling to avoid freezing, moulting may increase individual's supercooling ability especially in Collembola and the activity of ice nucleating bacteria in cold hardy arthropods may be important. Vegter et al. (1988) studied on the community structure, distribution and population dynamics of Entomobryidae (Collembola), they argue that, in contrast to conventional theory, this hierarchical structure of collembolan communities does not characterise assemblages in an early successional state but that it is typical for developed communities where more and more species are forced into secondary roles. Anderson (1988) worked on spatiotemporal effects of invertebrates on soil processes. According to him, litter-feeding macrofauna have a tremendous impact on decomposition because they process large amounts of litter. Sinha et al (1988) were of the view that not a single factor but a cumulative action of a number of factors are responsible to control the seasonal periodicity of soil mesofauna. Sinclair (1989) studied on the population regulation of animals, his research was designed to investigate whether, and by what means, springtail and mite numbers are regulated. A regulatory factor is any density-dependent process that keeps populations within predictable density ranges by affecting population growth quantifiably. Villani and Wright (1990) studied the environmental influences on soil microarthropods behaviour in agricultural systems. Hagvar and Abrahamsen (1990) worked on the Microarthropod and Enchytraeidae (Oligochaeta) in a naturally lead-contaminated soil: a gradient study. According to them, anthropogenic activities may have persistent and long lasting effects on Collembola, although with long-term (centuries) exposure, springtails can become tolerant to metals. They have also found that species number decreased with increasing Pb concentration along a gradient. Aber et al (1990) studied on predicting long-term patterns of mass loss, nitrogen dynamics, and soil organic matter formation from initial fine litter chemistry in temperate forest ecosystems. According to them, on the basis of the close correlation between litter quality and decomposition, litter traits can be used as predictors for decay rates across species. Riechert and Bishop (1990) worked on Prey control by an assemblage of generalist predators: spiders in garden test systems. According to them, in agricultural systems, a clear positive correlation between the amount and composition of plant residues and the density and diversity of decomposer and predator organisms has been observed. These relationships are of key importance for successful pest management, and therefore, a thorough understanding of trophic interactions and controls in food webs is necessary. Blair et al (1990) studied on decay rates, nitrogen fluxes, and decomposer ectomycorrhizal and a leaf-saprotrophic basidiomycete colonizing beech leaf litter. They have reported a significantly higher N release from mixtures did not detect a concomitant change in mass loss. Verhoef and Brussaard (1990) worked on decomposition and nitrogen mineralization in natural and agroecosystems: the contribution of soil animals. They have reported that the direct contribution of decomposer invertebrates to energy flow and carbon mineralization is low (about 10%), whereas the direct effect on nutrient mineralization is somewhat higher (~30%).

In an interesting study by Joy and Pratim (1991) it has been shown that chemicals like Aldrin and Endosulphan adversely affect the density of soil microarthropods and specially the Acari and Collembola. Andow (1991) worked on vegetational diversity and arthropod population response. According to him, in forest and agricultural ecosystems, plant-species diversity and composition may determine the susceptibility to insect outbreaks. Ponge (1991) worked on food resources and diets of soil animals in a small area of Scots pine litter. According to him, the factor which has been considered to have a high influence on the food preference is the microhabitat where they are living; but there are cases where the species share the microhabitat, but differ in the food they take. So, it has been observed that in soil and litter there is preference for fungal spores and mycelia, bacteria and fecal pellets, while the species which climb trees or always live in the canopy, ingest pollen grains and spores more often. Wolters (1991) worked on soil invertebrates: effects on nutrient turnover and soil structure. According to him, the indirect effect of soil invertebrates on litter decomposition through litter fragmentation and modifications of the structure and activity of the microbial community considerably exceeds the direct effect via their own metabolism. Myrold and Nason (1992) worked on the effect of acid rain on soil microbial processes. According to them, the impact of acid rain on soil fauna has been extensively investigated. However, the direct effects of acid precipitation on soil animals are poorly understood. Collembolans are important members of the soil mesofauna and play an important role in organic matter decomposition in soil. Lavelle et al (1992) worked on a hierarchical model for decomposition in terrestrial ecosystem: application to soils in the humid tropics. According to them, ecological studies of soil animals have been focused on macro-soil animals such as termites and earthworms, which are important ecosystem engineers in tropical soils. However, there are rather few ecological studies of microarthropods such as Collembola and Acari. These arthropods have high abundances in boreal and temperate forests and have a significant function in decomposition processes in forest soils. Hobbie (1992) worked on the effects of plant species on nutrient cycling. According to them, plant-species composition, in turn, significantly affects ecosystem nutrient cycling through plant-nutrient uptake and use, rhizosphere interactions, production of litter of specific quality, and microenvironmental changes. Shaw (1992) worked on fungi, fungivores, and fungal food webs. According to him, laboratory experiments suggest that some fungivores (Collembola, Nematoda) prefer ectomycorrhizal over saprotrophic fungi, but this pattern varies according to specific features of animal and fungal species. In particular, collembolans avoid toxic species of mycorrhizal basidiomycetes. Lussenhop (1992) studied on mechanisms of microarthropod-microbial interactions in soil. According to him, selective grazing affects fungal biomass and activity, interrupts bidirectional nutrient transfer between decomposing litter and plant roots, regulates fungal succession in decaying litter, and can strongly reduce mycorrhizal mycelium. Crosseley et al (1992) stated that microarthropods participate in the complex food webs of soil. They have impact on organic debris, microbial decomposers, nematodes, roots and pathogenic fungi. Kaczmarek (1993) worked on Collembola and reported that more than 90% of Collembola inhabit the top 10 cm of soil. Thus, soil cores of 10 cm depth were considered to be sufficient to sample most of the springtails. Stork and Blackburn (1993) worked on Abundance, Body Size and Biomass of Arthropods in Tropical Forest. According to them, in the rain forests of Seram; Indonesia, Collembola comprise about 20% of the total number of arthropods on tree trunks and 50% and 60% of the total from soil and leaf litter, respectively (Stork and Blackburn). However, because of their small size the contribution of Collembola to total soil animal biomass and respiration is low, typically between 1% and 5% in temperate ecosystems, but up to about 10% in some arctic sites and as much as 33% of total soil fauna respiration in ecosystems in early stages of succession. Typical values for the dry weight of springtails in temperate ecosystems are 0.15 gm^{-2} in deciduous woodland and 0.3 gm^{-2} in limestone grassland. Perry et al (1993) studied on using response-surface methodology to detect chaos in ecological time series. According to them, most long-term census data on insect and vertebrate species have been analysed on a yearly time scale so that abundance in any given year is related to that in the previous year, yet dynamics of populations within years (e.g. seasonality) form the basis of many insect population dynamics. Yuqing et al (1993) studied on Abundance of carabid beetles and other ground-dwelling arthropods in conventional versus low-input bean cropping systems and reported that the impact of cropping practices on the abundance of soil artropods differs with species; many species were equally abundant in both conventional and low-input plots or had higher densities in the conventional or in the low-input plots. They also noted various carabid species that could spread from 1 to 49 ha in an active season and they claim that these movements between conventional and low-input plots may also indicate selections in resources, in which the carabids depend on, and in microclimatic conditions between the plots investigated. In another study, Vreeken-Buijs et al (1994) described microarthropods biomass C–dynamics in the below ground food webs of two arable farming systems. In their study, the most abundant functional groups were omnivorous Collembola, omnivorous – non – cryptostigmatic mites and predatory mites. He found no relation between the biomass of the microarthropods and their main food source.

Kuznetsova (1994) worked on Collembolan Guild Structure as an Indicator of Tree Plantation Conditions in Urban Areas and reported that the composition of fluctuating communities of mixed and ruderal types is even more variable. Due to the "insular effect," the urban soils under neighboring trees growing in the openings in pavement may be inhabited by different sets of springtail species with the local prevalence of any group of life forms, as well as with different dominant species. Jones et al (1994) studied on organisms as ecosystem engineers. According to them, the ecosystem consequences of the diversity of soil organisms are little understood, except for some keystone species or ecosystem engineers such as earthworms, termites, and ants. Hägvar (1994) Studies on springtails have shown that their natural communities (taxocenes) are multispecific groups organized on the basis of resource partitioning and competition between species, and their dynamics are generally predictable. Studies have shown that soil fauna improve agricultural productivity through their activities on soil (Tinzara and Tukahirwa 1995). An other important work done by Coulson et al (1995), who postulated the low temperature performance of soil microarthropods at Nyalesund Spitsbergn. He concluded that the supercolling activity of these animals decreased rapidly on regaining activity in spring starvation for 14 bands desiccation or a combination of both, resulted in little change in the means super cooling point of Collembola.

Chernova et al (1995) studied on the Changes in population growth rate of springtails (Collembola) under the influence of herbicides. According to them, tests on *F.*

candida provide direct information only about the effects of chemicals on *F. candida*. How representative is this species of all Collembola? Most studies show that *F. candida* is among the most sensitive springtails to the majority of chemicals. Anderson (1995) worked on soil organisms as engineers: microsite modulation of macroscale processes. According to him, in natural ecosystems, and less so in agricultural ecosystems, the soil represents the habitat for a tremendous diversity of organisms. Moreover, soil itself is largely built through the action of animals, particularly primary and secondary decomposers. Laakso et al (1995) studied on The dominance of food generalists suggests high redundancy among soil animals, which supports evidence of a weak relationship between soil-animal diversity and ecosystem processes observed in various experiments. Filser et al (1995) worked on the effects of previous intensive agricultural management on microorganisms and the biodiversity of soil fauna. According to them species assemblages in polluted soils may change due to quantitative and qualitative changes in food, increased bioavailability of metals, avoidance of contamination by migration, and species-specific detoxification abilities. Some Collembola are specialist feeders and have preferences over which species of fungi they consume. The metal tolerant fungus, Paecilomyces farinosus, is protein rich. Therefore, there may be a trade-off between high quality food and metal toxicity to Collembola, suggested that Cu decreased or changed the microbial flora, which decreased the species number and abundance of Collembola when Cu was added to the soil. Dmowska (1995) studied on influence of stimulated acid rain on communities of soil nematodes. According to him, decades the impact of acid rain on soil fauna has been extensively investigated. However, the direct effects of acid precipitation on soil animals are poorly understood. Collembolans are important members of the soil mesofauna and play an important role in organic matter decomposition in soil. In this experiment, the potential impact of low environmental pH on the soil collembolan *Onychiurus yaodai* was studied under laboratory conditions. O. yaodai is widely distributed around Shanghai and easily cultivated in the laboratory. Dallai (1995) studied on the genus Isotomurus: where molecular markers help to evaluate the importance of morphological characters for the diagnosis of species. According to them, as taxonomical categories of Collembola are entirely based on morphology, molecular approaches to explore the evolution of the group are necessarily linked to morphological ones. Limits to morphological approaches are obvious at two main levels: in the process of disentangling species clusters, sibling species and color pattern forms, and in many aspects of phylogenetic reconstructions. Molecular tools are extremely useful in these critical situations. They help evaluating the interest of tenuous morphological characters, such as in Isotomurus. Park and Cousins (1995) worked on soil biological health and agro-ecological change. According to them, soil macrofauna, invertebrates with a diameter larger than 2 mm, are diverse, abundant and multifunctional elements of most soils. They are considered useful indicators of soil health since they play diverse roles on the biological regulation system of soils, depending on their habits, distribution and abundance. Also because they are widely distributed, have diverse habits, are sensitive to disturbance, highly abundant and are easily captured and studied. Hagvar (1995) studied on instability in small, isolated microarthropod communities and suggested that populations of springtails are considered to be controlled by exogenous factors such as temperature and moisture or predation.

Coulson et al (1996) had been observing consequences of tent warming on the Webb habitats for 3 years, by simulating excessive summer warming. The number of young Oribatid individuals had increased in semi-desert habitats, but no other significant change had been observed. Krest'yaninova and Kuznetsova (1996) studied on The Dynamics of Collembolan Community (Hexapoda, Collembola) in the Soil of a Boulevard. According to them, the ruderal communities cannot be stable, as they are confined to the initial stages of succession and, hence, are short-lived. The modular communities are formed under hard-to-predict conditions of urban soils, in which one biotopic group of springtails can gain an advantage over the others depending on random events: compost species actively develop in the presence of organic debris; ruderal species, upon an increase in recreational load; forest species, in fallen leaves; etc. However, it is possible to achieve the artificial quasi-stability of these communities by maintaining constant environmental conditions. Hodkinson et al (1996) applied both laboratory and field manipulations, including treatments with temperatures of 30^{o}C and above. It was found that negative effect affecting Oribatids could be experienced only above 35^{o}C, and time interval is an important factor in treatments around 30^{o}C. The extent of tolerance also depends on the moisture of the soil, but it was found that warming had no strong deteriorating effect on Oribatids. Zinkler and Platthaus (1996) studied on tolerance of soil-dwelling Collembola to high carbon dioxide concentrations. According to them, in soil, levels of carbon dioxide in pockets of trapped gas can be high. *F. candida* has evolved to survive in such conditions for considerable periods and is capable of becoming the dominant species in communities of Collembola subjected to elevated carbon dioxide. The species can survive up to 25% carbon dioxide for one hour or 10% carbon dioxide for six weeks.

Beare et al (1997) worked on agricultural intensification, soil biodiversity and agroecosystem function in the tropics: the role of decomposer biota. According to them, the relevance of using soil organisms e.g. earthworms and termites to monitor soil ecosystem health is validated by the recognition that they are essential to ecological processes and they also depend on soil as habitat. Trublaevich and Semenova (1997) studied on the estimation of soil toxicity using a laboratory culture of springtails (*Folsomia candida*). According to them, a variety of routes of exposure of *F. candida* to chemicals have been studied. These include food, gas, water, contaminated leaf surfaces over which the collembolans were forced to walk, and topical application of substances onto individual springtails. Van Straalen and Verhoef (1997) worked on the development of a bioindicator system for soil acidity based on arthropod pH preferences. They have investigated that the substrate pH preference of *O. yaodai*, the bottom of a glass chamber was divided into 4–5 pH zones covered with thick filter paper saturated with different pH buffers. The main buffer used was citrate-phosphate buffer, which consists of a solution of di-sodium hydrogen phosphate (Na_2HPO_4) and citric acid ($C_6H_8O_7$). Some experiments were repeated using McIlvaine's buffers with equalized ionic strength to ~100mM. The pH was checked before use at room temperature. The animals (20–30 collembolans) were introduced into the middle of the chamber and allowed to move freely between different pH zones. The distribution of the animals in the chamber was recorded in a time-course as indicated in the results. In control experiments animals were placed in a chamber in which all the zones were covered with the same papers saturated with water (~pH 6). Vandermeer and Perfecto (1997) worked on the agroecosystems: a need for the conservation biologist's lens. According to them, although biodiversity loss has been given prominence all over the world in the last 2-3 decades, most of the conservation efforts have been directed to above ground and in particular large plant and animal species of economic and aesthetic value while smaller animals and lower plants and below ground organisms such as earthworms, termites, bacteria and fungi have seldom been considered among endangered species. Biodiversity loss therefore, seems to attract public attention only when large charismatic, species are endangered or romantic habitats are threatened while hotspots of biodiversity are chosen based on above ground species. Doran and Safley (1997) worked on defining and assessing soil health and sustainable productivity. According to them, agricultural practices often deplete soil organic matter and alter composition and abundance of soil biota. Consequently, physical and chemical properties such as exchangeable cations, soil water retention capacity, contents of fundamental elements and pH, decrease also denoting a general decrease in soil function. Babenko (1997) studied on the taxonomy and distribution of the genus Anurida (Collembola: Neanuridaė) in the northern Palaeartic. According to them, at generic level, Micranurida, Cephalachorutes and Isotomiella are best defined by their antennal chaetotaxy. At species level, antennal characters have been successively used in Anurida.

Heneghan et al (1998) studied the influence of climate, substrate quality and microarthropods on decomposition of litter from different forest sites. An important aspect of the effect on microclimatic condition on the interaction within soil faunal communities was observed by Huhta et al (1998). It was observed that in the presence of Collembola (*Folsomia sp*) the nematode population was greatly depressed at medium and high level of moisture. Van Straalen (1998) studied on the evaluation of bioindicators systems derived from soil arthropod communities. According to him, long-term acid deposition depletes soil buffering capacity and eventually decreases soil pH. This change is potentially harmful to many soil animals. However, different soil animals show different pH preferences, even in Collembola, the pH preferences by different species are widely distributed from pH 2.9 to 7.3. Bengtsson (1998) studied on which species? What kind of diversity? Which ecosystem function? Some problems in studies of relations between biodiversity and ecosystem function. They have been reported that a declining biodiversity is consistent with reduced ecosystem function. However, functional diversity can be difficult to measure and so species diversity is usually estimated instead. Rusek (1998) worked on biodiversity of Collembola and their functional role in the ecosystem and observed that soil dwelling Collembola have mostly been linked to the detritus based food web because they typically feed on decomposer organisms. Mikola and Setala (1998) worked on productivity and trophic-level biomasses in a microbial-based soil food web and they have noted weak or no effects of predators on prey in soil systems. Although predators can have an indirect effect on the rate at which microbes are consumed, the micro-flora can compensate for biomass consumption by altering rate of turnover. Sadaka-Laulan et al (1998) studied on Feeding preferences of the collembolan *Onychiurus sinensis* for fungi colonizing holm oak litter (*Quercus rotundifolia* Lam.). According to them, in natural environments, Collembola feed on a great variety of resources, such as fungi, bacteria, mosses, pollen grains, spores, decaying plants and debris. Meyer et al (1998) studied on decreases in soil microbial function and functional diversity in response to depleted uranium. In their studies found slower decomposition in response to decreased bacterial functional diversity caused by depleted uranium application. Finzi and Canham (1998) worked on non-additive effects of litter mixtures on net N mineralization in a southern New England forest. According to them, a higher nitrogen flux from a more diverse litter than from single-species litter most likely results in higher plant N availability that possibly increases plant growth or alters the competitive balance among species. In contrast, decreased N loss from mixtures may indicate a diminished plant N availability caused by increased N immobilization or decreased N mineralization. This condition, however, does not necessarily imply negative consequences for ecosystem properties. For example, negative litter-mixture effects on N release can help to prevent N losses from the system after disturbances. Also, mixtures may not actually decrease N availability over longer time periods but may change the timing of N release not assessed in most experiments, which typically have a relative short duration. A different pattern of N availability over time could better match plant requirements or could favor some plant species over others. Vreeken-Buijs et al (1998) studied the relationship of soil microarthropods biomass with organic matter and pore size distribution in soils under different land use. The concluded that microarthropod biomass was larger in sandy soil than in loamy soil and generally larger in meadows than in wheat fields. In a study on the affect of drought on springtails it was observed that same epegial collembolans in arable land system are able to survive long periods of drought by Alvarez et al (1999). These finding have implications on the predicted climate changes upon collembolan population.

In a study conducted by Heneghan et al (1999), he stated that soil microarthropods contributions to decomposition dynamics tropical temperate comparison of a single substrate. They hypothesized that microarthropod relation of the microbial population involved in leaf litter decomposition would be stronger in humid tropical forests. Martin et al (1999) studied on Soil microbial diversity, community structure and denitrification in a temperate riparian zone. According to them, a positive correlation between overall functional or taxonomic diversity of soil bacteria and denitrification rates was found in both laboratory and field studies. Maraun et al (1999) studied on middens of the earthworm *Lumbricus terrestris* (Lumbricidae): microhabitats for micro- and mesofauna in forest soil. According to them, litter-feeding macrofauna have a tremendous impact on decomposition because they process large amounts of litter and because of their feedback on performance, activity, and community composition of microbial decomposers and smaller litter and soil fauna. Behan-Pelletier (1999) emphasized that the most abundant and diverse group of soil mesofauna were the Oribatids even in forest habitats. Changes in this community can have an important indication role. According to him, the density of groups with parthenogenetics reproduction increased following distribution, which could cause changes in the structure of the community. Several studies tried to determine the changes in Oribatid communities caused by distributions in forest habitats. Numerous types of distributions have been examined in forests but these studies are hard to compare and as a consequence, obtained various results. Kaneko and Salamanca (1999) studied on mixed leaf litter *effects on decomposition rates and soil microarthropod communities in an oak-*pine stand in Japan and they who observed a higher species richness of oribatid mites and a higher abundance of microarthropods in litter mixtures compared with single-species litterbags. However, the two studies are in contrast with respect to litter-mass loss. Whereas the greater faunal abundance and diversity correlated with increased mass loss in the experiment, found no effect on litter-decay rate. These results might be seen as evidence for a greater importance of faunal abundance over faunal diversity for process rates. Nilsson et al (1999) worked on the effects of plant litter species composition and diversity on the boreal forest plant-soil system. They have documented that competitive interactions among plant species change when plants are grown in humus formed from monotypic versus mixed litters, although these effects were small and tended to be idiosyncratic. Altier (1999) worked on the ecological role of biodiversity in agroecosystems and observed that enhance functional biodiversity in agroecosystems is a key ecological strategy to bring sustainability to production. Thus, the development of agroecological technologies and systems, which emphasized the conservation-regeneration of biodiversity, soil, water and other resources, is urgently needed to meet a growing array of socioeconomics and environmental challenges. Kampichler et al (1999) worked on field mesocosms for assessing biotic processes in soil: how to avoid side effects. According to them, the addition of organic fertilizer to industrial wasteland increases vegetation cover/plant complexity, which can increase species richness and abundance of soil animals.

Vu et al (2000) worked on microarthropod community structures (Oribatei and Collembola) in Tam Dao National Park, Vietnam and their results have shown that microarthropod community structures, particularly species diversity of oribatid and collembolan communities, are related to forest decline. Therefore, they can be used as bioindicators of forest plant succession. In Tam Dao National Park, there was an inverse relation between species diversity of the oribatid and collembolan communities. The species diversity of the oribatid community gradually decreased with forest decline whereas the species diversity of the collembolan community gradually increased. Herrick (2000) worked on soil quality: an indicator of sustainable land management. According to them, measurements of soil health by means of indicators allow us to understand how soil capacities and properties evolved under certain management systems either for food production or development of environmental functions in several time-space scales. Within this context, it is important to choose the indicators that give complete information about its properties, biological productivity and quality of surrounding environment. Rebecchi et al (2000) worked on the effects of a sulfonylurea herbicide on soil microarthropods. According to them, pollution of soil by a wide range of contaminants can change the species composition within the collembolan community in comparison to "clean" sites. Chernova and Kuznetsova (2000) worked on Collembolan Community Organization and Its Temporal Predictability. According to them, natural and anthropogenically disturbed communities of springtails can be mono- or polydominant. Thus, in the springtail communities of natural forests, dominance belonged to one species (bilberry pine forest, the Darwin Nature Reserve), two species (wood-sorrel spruce forest, Moscow oblast), and three species (green moss spruce forest, Moscow oblast), with this pattern remaining unchanged from year to year. Griffiths et al (2000) Studied on ecosystem response of pasture soil communities to fumigation-induced microbial diversity reductions: an examination of the biodiversity-ecosystem function relationship. According to them, experimental reduction in microbial diversity often did not affect gross soil processes or even increased the rate of decomposition of plant residues. After manipulation of the diversity of decomposer biota by use of chloroform fumigation, reported no consistent relationship between microbial diversity and process rates. Although nitrification, denitrification, and methane oxidation decreased along with decreasing biodiversity, plant-residue decomposition tended to be faster in pauperized soil. Axelsen and Kristensen (2000) studied on Collembola and Mites in plots fertilized with different types of green manure. According to them, Collembola are extremely abundant in soil and leaf litter. In most terrestrial ecosystems they occur in high numbers, typically between 104 and 10^5 m^{-2}. Densities of springtails of more than 10^5 m^{-2} have been found in pine forests in India and Japan, moorland in England, and dry meadows in Norway. Collembola are particularly abundant in agricultural soils that are farmed "organically". Zimmer and Topp (2000) worked on species-specific utilization of food sources by sympatric woodlice (Isopoda: Oniscidea). They have found that the saprophagous macrofauna preferentially feed on certain litter types and are quite sensitive to changes in quality, even within a single-litter species. Byers et al (2000) worked on richness and abundance of Carabidae and Staphylinidae (Coleoptera) in north eastern dairy pastures under intensive grazing. Great Lakes. Their studies have demonstrated that increased stocking rate contributes to a decrease in soil pore space, which in turn leads to a decline in microarthropod numbers because of modifications in habitats (Bardgett et al 1993). Messer et al (2000) studied on Chemical deterrents in podurid Collembola and observed that whenever a podurid is touched by a predator the springtail crouches to the ground presenting to the attacker its back, where most of the pseudocelli are located, and immediately excretes repelling fluids. Chagnon et al (2000) studied on the community structures of Collembola in sugar maple forests: relations to humus type and seasonal trends. According to them, the soils in Wolverhampton displayed a high number of species with a low dominance and a low number of species with a high dominance. Lundberg et al (2000) studied on population variability in space and time. According to them, the analysis of variability and constancy in ecological populations and communities has been a focus of ecological research for decades and still is of the utmost importance for understanding the complexity of intrinsic and extrinsic forces that influence their temporal dynamics (Pimm and Redfearn 1988). Malysheva and Chernova (2000) studied on Springtails as Primary Colonizers of the Grounds of Sanitary Landfills and explained that with respect to the prevalence of a certain biotopespecific group, four categories of springtail communities can be distinguished: specialized, eurytopic, mixed, and ruderal communities. The specialized communities are characterized by the dominance of the corresponding species group (the conventional threshold is 40% of the total abundance) or, in some cases, two groups (e.g., the groups of forest and bog species in a pine–sphagnum bog). They are typical of the majority of natural forests, especially coniferous. In the eurytopic springtail communities (in most meadows of the forest zone, some broadleaf forests, and park forests), the eurytopic group prevails, and none of the specialized groups reaches the 40% abundance threshold. The modular communities include many ruderal or compost species, in addition to specialized and eurytopic species. For example, they are characteristic of most soils found in urban green areas. The communities with the prevalence of ruderal or compost species are classified as ruderal. They have been found in mounds of earth near construction sites. Hedlund and Sjogren Ohrn (2000) studied on tritrophic interactions in a soil community enhance decomposition rates. According to them, litter decomposition by twospecies or three-species mixtures of fungi did not exceed corresponding values in the best-performing monoculture. Anderson (2000) studied on food web functioning and ecosystem processes: problems and perceptions of scaling. According to him, effects of soil organisms on soil processes are intimately linked to their size. Small organisms such as bacteria, fungi, and protozoa are the key drivers of energy and nutrient transformations, whereas larger decomposer organisms such as earthworms, millipedes, and isopods are the dominant habitat transformers. Johnston (2000) studied on the contribution of microarthropods to aboveground food webs: a review and model of belowground transfer in a coniferous forest and found that surface-dwelling springtails are soft-bodied plankton of the soil. Winkler and Kampichler (2000) worked on local and regional species richness in communities of surface-dwelling grassland Collembola: indication of species saturation. According to them, Collembola show a hard upper limit to local species richness independent of the size of the regional pool. Although none of these observations in isolation can prove that Collembolan field populations are actually structured by internal biotic forces, the sum of empiric data along with the results of this study strongly suggest this. Oksanen and Oksanen (2000) studied on the logic and realism of the hypothesis of exploitation ecosystems. According to them, apparently, predation of springtails by mites has no dynamic feedback; contrary to speculation that predation by mites regulates springtails. Possibly, the low productivity of prairie ecosystems did not support a predator capable of regulating springtails and mites. Badejo and Ola-Adams (2000) worked on Abundance and diversity of soil mites of fragmented habitats in a biosphere reserve in Southern Nigeria and concluded that

1) Habitat fragmentation in the Biosphere Reserve leads to fragmentation of the soil mite community and alteration of their densities and diversity.
2) Plantation establishment brings about a dominance shift to other mite species.
3) Type of vegetation cover and the resulting litter as well as intensive agriculture affect mite population densities and diversity in the soil.
4) Low soil cryptostigmatid mite densities signify poor fertility in cultivated soils.

Loranger et al (2001) observed that the change in altitude caused a change in species composition of the soil microarthropod communities, because with the change in altitude there is change in the soil chemistry, humus forms and vegetation. Hattenschwiler and Bretscher (2001) worked on Isopod effects on decomposition of litter produced under elevated CO2, N deposition and different soil types. According to them, the saprophagous macrofauna preferentially feed on certain litter types and are quite sensitive to changes in quality, even within a single-litter species. Sabatini (2001) worked on interaction between plant pathogenic fungi and Collembola. According to him, Collembola may reduce disease by consuming pest fungi. Selective grazing by springtails may be an important factor limiting the distribution of certain species of basidiomycete fungi in the field. However, many of these effects are density-dependent, and too little information is available for quantifying accurately the specific contribution of Collembola to "indirect" or "catalytic" decomposition. Nevertheless, the influence of springtails on decomposition and nutrient availability must be significant in many ecosystems. Balachandran and Khillare (2001) worked on occurrence of acid rain over Delhi. According to them, acid rain in industrial regions around the world poses serious threat to the ecological balance and is of major environmental concern. Increasing evidence suggests that long-term acidic load reduces soil pH, directly damages vegetation and eventually leads to the collapse of ecosystems. Frampton (2001) worked on the large scale monitoring of non-target pesticide effects on farmland arthropods in England: the compromise between replication and realism of scale. According to him, anthropogenic activities may have persistent and long lasting effects on Collembola, although with long-term (centuries) exposure, springtails can become tolerant to metals. Soil microarthropods may have a high degree of site-specificity and are potentially good bioindicators of pollution. Takeda and Abe (2001) worked on templates of food-habitat resources for the organization of soil animals in temperate ad tropical forests. According to them, the functional groups of Collembola in the communities are related to the decomposition processes. Thus, a basic knowledge of population and community structures of soil microarthropods is important for understanding decomposition processes in tropical forests. Carapelli et al (2001) worked on taxonomical revision of 14 south-western European species of Isotomurus (Collembola, Isotomidae), with description of four new species and the designation of the neotype for *I. palustris*. According to them, as taxonomical categories of Collembola are entirely based on morphology, molecular approaches to explore the evolution of the group are necessarily linked to morphological ones. Limits to morphological approaches are obvious at two main levels: in the process of disentangling species clusters, sibling species and color pattern forms, and in many aspects of phylogenetic reconstructions. Molecular tools are extremely useful in these critical situations. They help evaluating the interest of tenuous morphological characters, such as in Isotomurus. They represent a powerful tool for reconstructing highest relationships in the order and to test the accuracy of current taxonomical hierarchy. Like in other zoological groups they are of increasing importance in all aspects of evolutionary biology of Collembola. Broza et al (2001) while working on the nonsusceptibility of soil

Collembola to insect pathogens and their potential as scavengers of microbial pesticides. Observed that *Folsomia candida* consumes and inactivates entomopathogenic fungi applied as biological pesticides without suffering mortality, reproductive disturbance, or any other harmful effects. Ferguson (2001) studied on changes in trophic abundance of soil arthropods along a grass–shrub–forest gradient. According to him, some general patterns in the trophic organisation of soil animal communities have been observed despite a high degree of stochastic variation high species diversity within trophic groups, tendency to trophic generalism, high numbers and fluctuating mesofaunal predators, and continuity in litter decomposition. Bridge and Spooner (2001) worked on soil fungi: diversity and detection. According to them, species diversity of soil fungi is probably only slightly less than that of bacteria (Hawksworth 2001). Cragg and Bardgett (2001) studied on how changes in soil faunal diversity and composition within a trophic group influence decomposition processes. According to them, the dominance of food generalists suggests high redundancy among soil animals, which supports evidence of a weak relationship between soil-animal diversity and ecosystem processes observed in various experiments (Ekschmitt et al 2001). Loreau (2001) studied on micobial diversity, producer decomposer interactions and ecosystem processes. According to him, soil microbial diversity has been hypothesized to correlate positively with process rates within soils. In one of the few models that linked microbial diversity and decomposition processes, and suggested that microbial diversity has a positive effect on nutrient-cycling efficiency and ecosystem processes through either greater intensity of microbial exploitation of organic matter or functional niche Complementarity. Simonsen and Christensen (2001) worked on clonal and genetic variation in three collembolan species revealed by isozymes and randomly amplified polymorphic DNA. They have most laboratories with cultures of *F. candida* will donate these. Although there are small differences in the responses of clones from different sources, these are not sufficient to be considered a significant problem. Loreau et al (2001) studied on biodiversity and ecosystem functioning: current knowledge and future challenges, their experiments have shown that, in grassland ecosystems, primary productivity is positively related to plant-species diversity. Knapp et al (2001) studied on the frequency and extent of water limitation to primary production in a mesic temperate grassland. According to them, contrary to the top-down hypothesis, evidence was found for bottom-up control of springtail and mite abundance that may relate to low productivity on the prairies. Knapp and Smith (2001) studied on variation among biomes in temporal dynamics of aboveground primary production and concluded that springtail and mite population density was determined primarily by endogenous factors (delayed density-dependent regulation), which provided a reasonable description of density changes without invoking top-down predation. The predominant factor explaining springtail and mite population growth was 1-week lagged density, whereas including temperature in the model together with delayed density-dependent factors explained additional variance in springtail and mite density. Regulation may occur by means of density-dependent processes acting within years whereas changes in year-to-year abundance may be due to differences in annual temperature and precipitation that may vary spatially with primary productivity. Future studies should use experimental approaches to understand the effects of delayed density dependence and rainfall on the demographic processes of survival, reproduction, immigration, and recruitment of springtails and mites.

Prosser et al (2002) studied on molecular and functional diversity in soil micro-organisms. They have reported that soil carbon and energy flow is mainly driven by microbial activity. The diversity of soil microorganisms is assumed to be extraordinarily high but is largely unidentified. Bandyopadhyaya et al (2002) worked on the effect of some physical factors and agricultural practices on Collembola in a multiple cropping programme in West Bengal (India) and summarized that collembolan populations were followed monthly for 3 years in a long-term cultivated and fertilized agricultural field, in East India (West Bengal). Where three crops (jute, paddy rice and wheat) were cultivated and subjected to various doses of NPK fertilizers, herbicides and organic manure. Each crop showed a rise followed by a decrease in collembolan populations. When crossed with crop effects collembolan populations showed a negative correlation with soil temperature and a positive correlation with soil moisture. Application of organic manure induced an increase in the population but the effects of fertilizers and other treatments applied to the field were not as significant as seasonal and crop influences. Petersen (2002) studied on general aspects of collembolan ecology. According to him, collembolans are common detritivorous and fungivorous microarthropods found throughout the vertical structure of forests from the aboveground parts (canopy) to the belowground parts (soil), and they play important roles in the functioning of detrital food webs. Mikola et al (2002) studied on biodiversity, ecosystem functioning and soil decomposer food webs. In *Biodiversity and Ecosystem Functioning—Synthesis and Perspectives*. They have reported that a data compilation that included 24 studies indicated that in virtually all cases, soil animals of the entire decomposer spectrum, from protists to macroarthropods, stimulated decomposition and nutrient mineralization through their effects on microorganisms. Steven and Damien (2002) investigated whether populations are regulated by density dependent predation. They proposed that composition resources regard each trophic level. Ferguson and Joly (2002) studied on dynamics of springtail and mite populations: the role of density dependence, predation, and weather. They have presented evidence for endogenous control of springtail numbers on forest soils in intra-annual time series by finding negative correlations between population growth rate and 1-week lagged density. It has been suggested that intra- and inter-specific competition and/or predation may lead to the deterministic community structure of the soil fauna, and the evidence that Collembolan communities in particular are structured by intensive biotic interactions has been growing during the last 15 years. First, a number of early laboratory experiments had demonstrated considerable biotic interactions between Collembolan populations (Christiansen et al 1992), including direct interaction, substrate conditioning and airborne allomones. Second, Collembolan populations are food-limited and their density in the field could be increased by 3–4 times in a food enhancement experiment. Ekblad and Nordgren (2002) worked on is growth of soil microorganisms in boreal forests limited by carbon or nitrogen availability? According to them, saprotrophic fungi (ST) fungi, especially basidiomycetes, are generally more effective in breaking down dead organic matter and are almost exclusively responsible for decomposition of lignocellulose. However, because of the wide C/N ratio in most litter types, the activity of litter-decomposing fungi in temperate forests is often restricted by N availability. Lindahl et al (2002) studied on defining nutritional constraints on carbon cycling in boreal forests—towards a less 'phytocentric' perspective. According to them, ectomycorrhizal (EM) and saprotrophic (ST) fungi compete for nutrients (including organic nitrogen compounds) in forest soil, and antagonistic interactions are presumably common between these organisms. Scheu and Setala (2002) worked on multitrophic interactions in decomposer communities. According to them, the generalist feeding habit of soil predators is an important prerequisite for this interconnection of the belowground and aboveground food web. Generalist feeding, including polyphagy, omnivory, and intraguild predation, appears to be a characteristic feature of soil predators. Mader et al (2002) worked on soil fertility and biodiversity in organic farming. According to them, in agricultural systems, a clear positive correlation between the amount and composition of plant residues and the density and diversity of decomposer and predator organisms has been observed. These relationships are of key importance for successful pest management, and, therefore, a thorough understanding of trophic interactions and controls in food webs is necessary.

Lindberg et al (2002) conducted extensive studies in Swedish coniferous forests concerning drought effects. He also pointed out that long-term deprivation of precipitation decreases the abundance of Oribatid mites and the diversity of the community. They also examined what kind of long-lasting effects have been caused by draught to the community and how long the regeneration would take: he could not measure similar results even three years after the intervention comparing treated and untreated control sites. Besides, he pointed out that Oribatid mites are more sensitive and possess much moderate regeneration ability compared to Collembola or Mesostigmata (Lindberg and Bengtsson, 2005).

Gerlinde et al (2003) reported that soil invertebrate fauna enhance grassland succession and diversity. They concluded that soil microarthropods strongly affect the composition of natural vegetation. Duelli and Obrist (2003) studied on biodiversity indicators: the choice of values and measures. According to them, among reasons advanced for the need for biodiversity protection is that: biodiversity represents a potential reserve of new compounds for medicine, interesting genes for plant breeding and services for agriculture. Eviner and Chapin (2003) worked on functional matrix: a conceptual framework for predicting multiple plant effects on ecosystem processes. According to them, *plant-species composition, in turn, significantly affects ecosystem nutrient cycling through* plant-nutrient uptake and use, rhizosphere interactions, production of litter of specific quality, and microenvironmental changes. Distinguishing these different controls is essential for a mechanistic understanding of biodiversity effects on ecosystem functioning. Krivtsov et al (2003) worked on some aspects of complex interactions involving soil mesofauna: analysis of the results from a Scottish woodland. They have showed that collembolan diversity conducted in woodlands in Scotland, it was the most abundant species. Hilligsoe and Holmstrup (2003) studied on Effects of starvation and body mass on drought tolerance in the soil collembolan *Folsomia candida*. They have reported that all life stages of *F. candida* are well adapted to dry soil conditions. The species possesses physiological adaptations to desiccation and absorbs water vapor and remains active below 98.9% relative humidity (RH) (the permanent wilting point of plants). Palacios-Vargas and Castano-Meneses (2003) studied on seasonality and community composition of springtails in Mexican forests. According to them, *Seira purpurea* was the species in which animal remains were more often found. This is of interest because, even if it is not an abundant species in the epiphytic plants, reaching only 2% of the total abundance in the rainy seasons, its abundance increased during the dry season, reaching 8% of the total number of springtails; this species also showed variation in dietary components. Uvarov (2003) pointed out that daily temperature fluctuation of the soil affected the survival and reproduction ability of Oribatids. Fluctuations with in 5°C and 25°C had strong negative effects, while fluctuations with 10 and 20°C enhanced reproduction. Intermediate values had been gained by measurements on constant 15°C. In order to explore long term changes in microarthropod communities after introduction of livestock grazing in abandoned fields by Petersen et al (2004) in a three year study on soil arthropod community of a dry evergreen forest, observed that grazing by domestic animals constitute a profound human influence in terrestrial ecosystem. In a study related to population abundance, species composition, and community structure of Collembola and Acari, Wiwatwitaya and Takeda (2004) found that humidity was the most important factor determining distribution, abundance and survival of soil Collembola. Bardgett and Wardle (2003) studied on herbivore-mediated linkages between above ground and below ground communities. According to them, herbivory by grazing mammals affects decomposer communities principally through (i) changes due to differences in the patterns of root exudation and carbon allocation, and (ii) changes due to alterations in the quality and quantity of plant litter. In temperate grasslands such effects from herbivory result in positive feedbacks to soil biological communities and their processes, thus enhancing plant productivity. However, such positive feedbacks principally occur in grasslands of high soil fertility where herbivory prevents colonization by the successional plants, which produce litter of low nutrient quality (Bardgett et al 1997, Augustine and McNaughton 1998). Changguo et al (2003) worked on the case study on soil fauna diversity in different ecological system in Shilin National Park, Yunnan, China and concluded that The Acarina, Collembola, Nematoda, Coleoptera and Opistopora are the dominant communities, Onchytraeidae, Opilions, Lepidotera, Diptera are the normal community; others are the scarce community. Painolaspidae is adaptive in any environmental vegetation. Gross biomass amounts of community and the index of biodiversity in the soil of natural bush are much higher than those in the soil of other degraded vegetation, which show that the natural bush is the ecological screen protecting the soil fauna from deterioration. The gross biomass of soil fauna is less than those in the forest of the same latitude and the diversity of soil fauna decreased sharply in the various degraded vegetation, which indicate the deterioration of the soil ecosystem.

In a study conducted by Rusek Josef (2004), concluded the biodiversity of Collembola and their functional role in the ecosystem. Collembola play an important role in plant litter decomposition process and informing soil micro structure. Fountain and Hopkin (2004) studied on biodiversity of Collembola in urban soils and the use of *Folsomia candida* to assess soil 'quality. They have reported that *F. candida* is a widespread and common animal. In ecotoxicology, it has been possible to relate soil pollution levels to the point along a pollution gradient where the species dies out. Setala and McLean (2004) studied on decomposition rate of organic substrates in relation to the species diversity of soil saprophytic fungi. Their studies showed a clear positive effect of fungal diversity on decomposition at relatively low diversity but no influence beyond an actual diversity of 5 to 10 fungal taxa. Southorn and Cattle (2004) worked on the dynamics of soil quality in livestock grazing systems. According to them, conventional Australian grazing practices allow stock to remain at low densities on pastures for specific periods of time, from 1-2 seasons in a year to several years. Such practices damage soil structure by compaction and alter the vegetation quality through selective loss of palatable plants resulting in lack of productivity and sustainability of the pasture in the long term (Greenwood et al 1998). Heemsbergen et al (2004) studied on biodiversity effects on soil processes explained by inter-specific functional dissimilarity. Despite the reasonable expectation that the diversity and composition of functional groups or feeding groups are important for ecosystem processes, the existence and the significance of the great species diversity within functional groups is puzzling.

Parisi et al (2005) worked on microarthropod community as a tool to assess soil quality and biodiversity: a new approach in Italy. They have used the Maturity Index (MI, Bongers 1990), which is based on nematode population, and the Qualita Biologica del Suolo (QBS-ar) index (Parisi 2001), based on soil microarthropods. Identical techniques were used on grassland and woodland sites located in the protected area. These soils, considered natural, were compared with that of the solid waste disposal site. The simultaneous use of MI and QBS-ar permitted the study of two large communities that present groups of organisms differing both in their ecology and their functions within the soil. Cole et al (2005) worked on relating microarthropod community structure and fertility manipulation in temperate grassland the high amount of energy transferred via plants to the soil in this habitat stimulates microbial growth, which results in an increased food resource for edaphic fauna. Lindberg and Bengtsson (2005) compared the effect of drought on Acari and Collembola and their subsequent recovery after drought. They concluded that surface living species which tended to have narrow habitat width were less negatively affected by the drought. Species with large habitat widths tended to recover faster after the drought. Overall collembolan species recovered faster than Acari. Maria et al (2004) in a significant study concludes that:

(1) Drought decreased soil water content and increased soil temperature hence decrease in microarthropod species.

(2) Irrigation treatments increased soil organic matter content and species richness. and

(3) *Infrequent irrigation increased maximum soil temperature and hence collembolans* show higher species evenness and diversity.

A few invertebrate groups occurred across all three soil types in similar abundances. Representative of the insect family Collembola, commonly known as Springtails, were always found to be one of the most abundant members of each community. Springtail species are known to be fungus, humus, or soil consumes (Wiwatwitaya and Takeda, 2005). Hattenschwiler and Gasser (2005) worked on soil animals alter plant litter diversity effects on decomposition. According to them, in most of the past experiments, mass loss was measured in litter mixtures as a whole and compared with the predicted or expected value on the basis of single species decomposition. This approach may mask species-specific responses to mixing litter that might well be important for decomposition processes. Individual species might behave distinctly, as was observed in most of the few studies that separated decomposition among species within mixtures. Bardgett (2005) found that in terrestrial ecosystems, the above- and belowground plant-litter input constitutes the main resource of energy and matter for an extraordinarily diverse community of soil organisms connected by highly complex interactions. In terms of biomass and species numbers, the largest number of soil organisms is involved in organic matter turnover, particularly the large groups of bacteria and fungi. Recycling of carbon and nutrients during decomposition is a fundamentally important ecosystem process that has major control over the carbon cycle, nutrient availability, and, consequently, plant growth and community structure (Wardle 2002). This places them in the category of decomposers and indicates that they play an important part in the breakdown of organic matter into new soil. Clergue et al (2005) worked on biodiversity: function and assessment in agricultural areas. According to them, biodiversity became a central concept in agronomical research. This event indicated a world consciousness of the importance of biodiversity protection for sustainable development. Tsiafouli et al (2005) conducted short-term manipulation studies in Mediterranean sites. Various irrigation and drying methods have been applied and it was shown that drought decreased the species richness of Oribatid and collembolan communities (differences in abundance were not significant), while irrigation increased diversity of both groups. This phenomenon could have been caused by the propagation of rare species after irrigation.

Fagan et al (2006) found in Canadian coniferous forests that species richness of Oribatids in the soil had been greater when comparing Oribatid communities of the foliage and soil. Diversity data can be found primarily in agricultural and forestry studies. It has been pointed out that irrigation (enhancing the moisture content of the soil) increased the diversity of Oribatid communities, because it raised the individual numbers of rare species (Tsiafouli et al, 2005). Ekelund et al (2006) described the significance of soil collembolans, Protozoa and micro organisms and their interactions for soil fertility which a key concept in this discussion. Here they refer to the view presented by Madar et al (2002) who suggested that fertile soils provide essential nutrients for crop plant growth, support a diverse and active biotic community exhibit a typical soil structure and allow for an undisturbed decomposition. An important aspect, at the same time given by Choi et al (2006) who observed a modelling study of soil temperature and moisture effects on population dynamics of *Paronychicrus kimi* (Collembola: oncychiuridae). They suggested that soil moisture is a major limiting factor on field population of *P. Kimi.* Arroyo and Iturrondobeitia (2006) worked on differences in the diversity of oribatid mite communities in forests and agrosystems lands. According to them, the significantly lower densities of mites and collembolans at the polluted habitats were probably caused by direct lethal effects on micro-arthropods, negative impact on their reproductive rates or indirectly on their food sources. The soil pollution might have posed a risk to soil processes and soil-based trophic networks. Pollution primarily caused decrease in density; however, Skubala and Kafel (2004) stated that species richness and density were also affected, while Migliorini et al (2005) observed qualitative changes. Qualitative (species richness) and quantitative (density) indices were adversely affected by the oil pollution. Badejo and Akintola (2006) studied on micro environmental preference of orbatid mite species on the floor of a tropical rainforest in Nig Exp. The have emphasized that the relationship between soil moisture content and the density of micro arthropods within the 0-5 cm soil litter. The work became imperative In view of the numerous benefits accruing from the continual presence of soil microarthropods to the field of Agriculture and ecosystem balance. Janssen et al (2006) added that, they have been convincingly useful for monitoring of heavy metal pollution in industrialized and urbanized areas. Though, there are enormous gaps in the knowledge of soil animals, some of the soil microarthropods have the potential of being excellent indicators of heavy metal pollution because of their relative history and limited tolerance to changes in environmental conditions. Johanna and Reynolds (2006) studied the effect of different cutting zone width on the structure and function of riparian zones within the Southern Appalachians and looked at the effects of riparian zone width on soil microarthropod populations, which play a critical role in decomposition by fragmenting leaf litter and adding vital nutrients to the soil. Preliminary results indicate high soil microarthropod abundance when soil temperatures are moderate. In another recent study, Eaton and Robert (2006) tried to isolate important factors from the terrestrial ecosystem by treatments. He observed that organic matter removal and vegetation control treatments had a significant negative effect on population during the late spring, summer and early fall months. Soil composition had no significant effect. Physical litter characteristics, nitrogen, phosphorous and carbon to nitrogen ratio were significantly correlated to collembolans population. Adl et al (2006) worked on slow recovery of soil biodiversity in sandy loam soils of Georgia after 25 years of no-tillage management. According to them, difficulties in its realization depending on crops and soils, it is a practice which is encouraged by means of agricultural policies because of its positive effects on environmental health. In the absence of the plough, the soil profile is undisturbed and the environment is less oxidative, the most important consequence being an improvement in soil quality and health over time. Syrek et al (2006) worked on the species abundance distribution of Collembolan communities in forest soils polluted with heavy metals. According to their studies conducted on the effect of land use intensification, soil chemistry and soil organic matter on the abundance and diversity of Collembola in France, Portugal and Brazil, have shown that, they have a significant effect on the population of Collembola communities (Jose et al 2004).

Sinka et al (2007) worked on the indirect effect of above-ground herbivory on collembola populations is not mediated by changes in soil water content. According to them, the *Paronychiurus kimi* population was unable to increase at 10% soil moisture content except when provided by a large amount of yeast. In a mesocosm study, showed that *Folsomia candida* have a higher tolerance for dry than for wet conditions. Yang et al (2007) worked on fertilisation responses of soil litter fauna and litter quantity, quality, and turnover in low and high elevation forests of Puerto Rico. They have investigated the relationship between soil fauna biodiversity, soil structure and function, the impacts of different agricultural practices, such as conventional tillage, no-till and fertilisation on the soil fauna biodiversity. Few studies have been carried out on the entire microarthropod community, much data regarding the most numerically important groups in the soil, such as Collembola and Acari. Groups such as Symphyla, Pauropoda, Diplura and others have scarcely been studied at all and the effects of agricultural practices on density and biodiversity are still unknown. Paoletti et al (2007) studied on the detritivores as indicators of landscape and soil degradation. According to them, among the acari, Cryptostigmata (Oribatids) are considered suitable indicators of soil systems; they have high diversity, densities and are sensitive to environmental changes. Reicosky and Saxton (2007) worked on the benefits of no-tillage. They have reported that no-tillage is one of the most sustainable soil management systems in that it increases soil organic matter, improves soil quality, reduces labour requirements and machinery costs, reduces fossil-fuel inputs, increases available plant water by reducing runoff and soil erosion, increases available plant nutrients, and improves the global environment.

Brussard et al (2007) worked on soil biodiversity for agricultural sustainability. According to them, the integrated management of soil fauna and agricultural practices is a holistic process that combines locally available resources, the climate, socio-economical conditions and management practices. Melamud et al (2007) showed increasing species richness proceeding upwards on Mt Carmel (Israel), while the moisture gradient has grown downwards. Chauvat et al (2007) studied on response of collembolan communities to land-use change and grassland succession. They have reported that the higher abundance of microarthropods allows the soil to perform key functions such as decomposition and nutrient cycling. In fact, most of the effects of edaphic fauna in fundamental processes for agricultural management are driven mainly by abundance and biomass rather than by species composition. Tripathi et al (2007) studied the mesofounal biodiversity and its importance in Thar desert. Their study supports that soil arthropods exhibited seasonal variation in their populations. There were two population peaks, one in February/March and other in August/September and faunal that the population showed a significant positive correlation with soil moisture, organic carbon and total nitrogen. Their study also suggests that the plantation may be done for improvement of physiochemical and biological health of soil on a sustainable basis in desert. Dermody et al (2007) worked on how do elevated

[CO_2], warming, and reduced precipitation interact to affect soil moisture and LAI in an old field ecosystem? According to them, climate changes, however, will not happen in isolation of one another. For example, elevated [CO_2] may ameliorate negative effects of soil drying through reducing plant stomatal conductance and transpiration, while increased evapo-transpiration resulting from higher temperatures may exacerbate effects of soil drying. Iloba and Odon (2007) worked on Studies on the biodiversity of soil microarthropods and their responses to Crude Oil Spills and concluded that concluded that the various populations or the biotic community of an established ecosystem is generally stable. However, the ability of a system in equilibrium to recover from a disturbance is an indication of its resilience. The biodiversity studies shows that disturbance in the form of crude oil pollution disrupted the activities of soil microarthropods rendering some dead and others redundant. If needed these soil microarthropods are functionally essential in maintaining soil ecosystem balance, their individual responses to perturbations become crucial. With the identification of sensitive, resistant and resilient species of soil microarthropods to crude oil pollution, it becomes easier to specify species that could serve as good bio-indicators of soil pollution. It has been proposed that there exist a strong inter- relationship between soil microarthropods and soil microflora (bacteria and fungi) which seem some what symbiotic in nature. Hence, soil microarthropods could also serve as good agents of bioremediation of organic pollution since microbes are functionally responsible for the break down of organic pollutants.

Cole ėt al (2008) stated that increasing the organic matter content of the soil had not affected the diversity of the Oribatids. Kibblewhite et al (2008) worked on soil health in agriculrural systems. Their results showed the soil fauna, a part of Eucaryota is grouped into macrofauna, mesofauna and microfauna. These soil biota contribute positively to ecosystem processes, which in turn support provision of ecosystems services that contribute to the maintenance and productivity of ecosystems by influencing soil quality and health (Brussaard et al 1997). Schrooder (2008) focused on mesofauna and great importance for the turnover of organic matter and decomposition process in soil. Yoshida and Hijii (2008) studied the efficiency of extracting microarthropods from the canony litter in a Japanese Cedar (Cryptomeria Japonica D. Don) plantation; a composition between washing and Tullegren methods. On the basis of the experiment, they suggested that the washing method is appropriate for the mite whereas Tullegren method is good for the Collembolan population. In another recent study, Steinaker and Wilson (2008) proved scale and density dependent relationships among roots, mycorhizal fungi and Collembola in grassland and forest. They concluded that Collembola were significantly positively correlated with root production in forest and with both fungal and root production in grassland.

Bautista et at (2009) studied on changes in soil macrofauna in agroecosystems derived from low deciduous tropical forest on Leptosols from Karstic zones and they concluded that ecological indexes and discriminant analysis revealed that macrofauna soil communities in agroecosystems and low deciduous tropical forest in Leptosols differ from each other. The practices of managing of the agroecosystems cause changes in the macrofauna communities and therefore it is possible to predict the structure of the community of macrofauna soil based in the management of the studied agroecosystems, focus on the response of specific macroinvertebrate taxa to soil disturbance. Hymenoptera and Orthoptera are the main groups that define the macrofauna soil communities. As it was expected from management intensity and periodicity, the least favorable agroecosystem for soil macrofauna was 12 year old star–grass pasture, which showed law richness, low–intermediate diversity and evenness and a homogeneous distribution of individuals among taxonomical groups of macrofauna. Silvopastoral system was the agroecosystem that less change (compared to the deciduous forest) produces in macrofauna soil communities. Orthoptera can be considered as indicators of healthy soils. In contrast, Coleoptera can be considering as indicator of soil degradation in grass agroecosystems in Leptosols from Karstic zones. Wachira (2009) and Okoth et al (2009) have reported enhanced population build up of fungi like *arthrobotrys* species in organic amendment plots. High organic matter, shade, high soil carbon and nitrogen have a significant influence in supporting high population of soil Collembola and Mites (Muturi et al 2009 and Maribie 2009). The presence of organic manure resulted in an increase in the abundance and diversity of total collembolan. Nishida et al (2009) worked on short-term response of abuscular mycorrhizal association to spider mite herbivory. According to them, aboveground herbivory by spider mites increased root biomass in a nutrient-rich environment. However, the effects of nutrient manipulation and aboveground herbivory on belowground biomass of intact plant communities in the Weld have rarely been examined. Anu et al (2009) worked on seasonality of litter insects and relationship with rainfall in a wet evergreen forest in South Western Ghats: according to them, invertebrate seasonality patterns play an important role in regulating the feeding and breeding patterns of many tropical rain forest vertebrate species. The data on the seasonal component of litter insect abundance from the Western Ghats forests will be useful in the effort to understand the breeding, foraging ecology and distributional pattern of insectivorous vertebrate species in the regions. Marinia et al (2009) worked on impact of farm size and topography on plant and insect diversity of managed grasslands in the Alps. According to them, Modern cultivation, chemical fertilization, artificial irrigation, pesticides, and herbicides are frequently employed in modern agriculture, and all are detrimental to soil organisms. The intensification of agricultural practices and the associated decline in natural habitats are the major drivers of biodiversity loss. Seymour and Collett (2009) Worked on the effects of fire retardant application on heathland surface-dwelling ant species (Order Hymenoptera; Family Formicidae) in Victoria, Australia. According to them, the humidity plays an integral part in softening the soil, which presumably enables them to build nests more easily. In turn, their nesting habits also greatly influence soil structure and their presence or absence has a strong influence on the distribution of other kinds of insects. Furthermore, they are important in many food webs, providing prey for a number of birds, reptiles and mammals; they also increase nutrient cycling. Yang and Chen (2009) worked on plant litter quality influences the contribution of soil fauna to litter decomposition in humid tropical forests, southwestern China. According to them, soil insects and other soil fauna enhance ecosystem services by accelerating key determinants of ecosystem primary productivity including organic matter decomposition, soil mineralization, energy flow, nutrient cycling and by maintaining soil physical structure. Soil insect diversity and abundance have been used as indicators of soil stress, soil quality, pollution, and environmental changes (Parisi et al 2005). Eyles et al (2009) worked on Shifts in biomass and resource allocation patterns following defoliation in *Eucalyptus globulus* growing with varying water and nutrient supplies, according to them, insect herbivory did not affect total belowground biomass production or fine root production, but it did lead to a decrease in coarse root production. These results are congruent with work on a single species—*Eucalyptus globulus*— which showed that herbivory aboveground can lead to reduced biomass production of coarse roots belowground. Karanja et al (2009) worked on soil macrofauna community structure across land use systems of Taita, Kenya, they demonstrated that quantitative change in diversity and density of soil fauna communities occur when various land use is subjected to varying levels of intensification. These changes could be associates with management practices that consequently results in destruction of nesting habitats, modification of soil microclimate within these habitat and removal of substrate, low diversity and availability of food sources for the associated macrofauna groups the significant correlation between some soil macrofauna groups with selected soil chemical properties shows that, soil chemical characteristics may indirectly play a role in influencing the density, distribution and structure of macrofauna communities. However, there is need to demonstrate how changes in macrofauna diversity and abundance associated with land use changes affect ecosystem functions and how such functions are beneficial at farm level.

Boer et al (2010) studied on the effect of soil pH and temperature on *Folsomia Candida* transcriptional regulation and their data showed that only 1 or 2 stress response genes were transcriptionally affected by pH and temperature thus exerting minimal effects. The physiological effects of these treatments on *Folsonia candida* might indicate interesting novel molecular mechanisms. Stein et al (2010) worked on Impact of invertebrate herbivory in grasslands depends on plant species diversity. According to them, insect herbivory can influence plant biomass production and community structure. However, no significant effects of insect herbivory on total aboveground biomass or on the biomass of dominant plant species. But they did find that, when insects were present, the biomass of subdominant species was nearly twice as high as when they were absent. Because aboveground herbivores often preferentially select high quality host plants, they can have dramatic effects on biomass of particular species, but still have little or no effect on total aboveground biomass of the entire plant community. Listed several reasons why the effects of herbivory on total aboveground biomass may be weak relative to nutrient manipulation. First, herbivores may have been limited by their own predators or by intraguild processes, which might be more common in high productivity environments. Second, some degree of compensation for herbivory, either by individual plant species or by the entire community, may occur such that if the biomass of one species goes down, the biomass of another (or others) increases. Third, taxa other than aboveground herbivorous insects (e.g., gastropods, voles, belowground herbivores) may consume more biomass in this ecosystem (Gruner et al 2008). Moron-Rios et al (2010) worked on the effects of seasonal grazing and precipitation regime on the soil macro invertebrates of a Mediterranean old-field. According to them, climate changes can influence soil microarthropod community abundance and composition directly by altering soil microclimate and indirectly by altering resource availability and the composition of the soil food web. Warming and changes in precipitation amounts, for example, can directly alter soil temperature and moisture, factors that strongly influence microarthropod reproduction and development rates. In fact, soil microarthropods are extremely responsive to changes in soil moisture, a pattern seen in numerous studies across diverse ecosystems. Castro et al (2010) worked on soil microbial community responses to multiple experimental climate change drivers. According to them, long-term ecosystem responses to atmospheric and climatic changes (hereafter 'climate changes') may largely depend on how the soil subsystem responds to these perturbations. While recent studies have focused on how climate changes can impact soil microbial communities and the ecosystem processes that they control, such as litter decomposition and nutrient cycling (e.g., Bardgett et al 2008), effects of climate changes on soil microarthropods received less attention (Hagvar and Klanderud 2009). Sackett et al (2010) worked on linking soil food web structure to above- and below-ground ecosystem processes: a meta-analysis. According to them, soil microarthropods play an important role in the functioning of the decomposer food web by, for example, exerting top-down control of primary (bacteria, fungi) and secondary (nematodes, protozoa) decomposers. Soil microarthropods also affect decomposition processes directly through fragmentation of litter and through fecal production. Iloba and Ekrakene (2010) worked on soil arthropods recovery rates from 5-10 cm within 5 months period following endosulfan (an organochlorine pesticide) treatment in designated plots in Benin City, Nigeria. According to them, there was consistent decrease in the mean numbers of soil arthropod sampled from April to June and the decrease was more as concentration of applied endosulfan increased. However, July to August witnessed very remarkable increase in mean soil arthropod sampled compared to the controlled stations, an indication of recolonisation. On the basis of concentration of endosulfan pesticide applied, the soil hydrocarbon content was significant ($P<0.05$) while soil pH, soil temperature and soil moisture were not. However, increase in soil moisture from April to August was observed to result in the increase in mean numbers of soil arthropod groups sampled. Besides the enhancement of agricultural productivity when the pesticides are properly applied, the problem of ecosystem imbalance has a natural solution path.

Okiwela et al (2011) studies on Soil microarthropods in a secondary rainforest, Rivers State, Nigeria: Ecosystem health indicators of oil pollution and the summarized that Comparisons were made of the species richness and densities of soil microarthropods- (mites, collembolans) from a relatively undisturbed secondary forest and a nearby area, where there had been an oil spill, approximately 1 year before the commencement of the 2 yr study, May, 2007 to April, 2009. Soil samples were taken monthly with an 8.5 cm diameter bucket-type auger. Extraction was by the Berlese-Tullgren funnel. Identification was undertaken with the aid of standard keys and comparisons were made with type specimens. Mean Total Hydrocarbon (THC) values were 630 mg/kg (43.0 to 1000.0) and 10 mg/kg at the polluted and undisturbed habitats respectively. Among the mites, Cryptostigmata (Oribatids) were dominant in both undisturbed (69.85%) and polluted (74.25%) habitats; the least abundant were the prostigmates. Within the oribatids, *Scheloribates* spp., *Galumnidae spp.*, *Parallonothrus nigeriensis* and *Bichythermamia nigeriana* were collected from both habitat types. In contrast, *Mixacarus* sp., *Aunecticarus sp.*, *Atropacarus sp.*, *Bellidae sp.*, *Cephalidae sp.*, *Oppia sp.*, *Basilobellidae* sp., *Epilohmaunia sp.*, *Mesoplophora sp.*, *Aecheogozettes magnus* and *Northrus lasebikani* were restricted to the undisturbed habitat. In the Mesostigmata, only *Parasiticidae sp.* and *Rhodacaridae sp.* were found in both habitat types; *Polyaspidae sp.*, *Uropodidae sp. and Asca sp.* were restricted to the undisturbed habitat. The Prostigmata, *Bellidae* sp. were collected from undisturbed and polluted habitats. Among Collembolans, *Cryptophagous* and *Paranolla* were found in both habitat types while *Hypogastina*, was restricted to the undisturbed habitat. Abundance and densities of mites and collembolans were respectively significantly reduced in the polluted habitat ($p < 0.05$; df = 9; F = 20.5; $p < 0.05$; df = 9; F = 30.08). N'Dri and Andre (2011) Studied on Soil mite densities from central Ivory Coast and summarized that Four sites, the Lamto savannah, the Oume primary forest and Oume teak plantation (Sudanese domain) and the Taï primary forest (Guinean domain) were sampled twice (in the rainy and dry season) in Ivory Coast. During this study three hypothesis were investigated: (1) soil mite densities vary with habitat type and season; (2) soil mite densities are affected by soil physico-chemical parameters; and (3) soil mite densities vary with depth (vertical distribution) and along transects (horizontal distribution). After a 1-week extraction in Berlese-Tullgren funnels, mite densities were higher during the rainy season than during the dry season. Despite the site and the season, density generally decreased from the litter to the deep layers despite the appearance of a bimodal distribution in some sites. The seasonal effect was more marked in topsoils.Inspite of the season, the same density succession was observed: Oume forest - Lamto savannah - Oume teaks - Taï forest. Major taxa Oribatida and Gamasida decreased with the depth in all sites and in all seasons. Contrary to what is observed in temperate areas, the soil depth 50 indicated that the study of top soils may be sufficient to describe the soil mite densities in the Tropics. Physico-chemical parameters such as water content and apparent density influenced the vertical mite distribution. Kardol et al (2011) worked on Climate change effects on soil microarthropod abundance and community structure and reported that Long-term ecosystem responses to climate change strongly depend on how the soil subsystem and its inhabitants respond to these perturbations. Using open-top chambers, we studied the response of soil microarthropods to single and combined effects of ambient and elevated atmospheric [CO_2], ambient and elevated temperatures and changes in precipitation in constructed old-fields in Tennessee, USA. Microarthropods were assessed five years after treatments were initiated and samples were collected in both November and June. Across treatments, mites and collembola were the most dominant microarthropod groups collected. They did not detect any treatment effects on microarthropod abundance. In November, but not in June, microarthropod richness, however, was affected by the climate change treatments. In November, total microarthropod richness was lower in dry than in wet treatments, and in ambient temperature treatments, richness was higher under elevated [CO_2] than under ambient [CO_2]. Differential responses of individual taxa to the climate change treatments resulted in shifts in community composition. In general, the precipitation and warming treatments explained most of the variation in community composition. Across treatments, they found that Collembola abundance and richness were positively related to soil moisture content, and that negative relationships between collembola abundance and richness and soil temperature could be explained by temperature-related shifts in soil moisture content. Their data demonstrate how simultaneously acting climate change factors can affect the structure of soil microarthropod communities in old-field ecosystems. Overall, changes in soil moisture content, either as direct effect of changes in precipitation or as indirect effect of warming or elevated [CO_2], had a larger impact on microarthropod communities than did the direct effects of the warming and elevated [CO_2] treatments. Moisture-induced shifts in soil microarthropod abundance and community composition may have important impacts on ecosystem functions, such as decomposition, under future climatic change. Wichaikam et al (2011) worked on seasonal and habitat-specific differences in soil insect abundance from organic crops and natural forest at the Ang Khang Royal Agricultural Station, Chiang Mai, Thailand and explained soil organisms play an integral role in decomposition and nutrient cycling, but pesticides and artificial irrigation from agriculture can kill soil organisms and thereby compromise the vital ecosystem services that they provide. Organic farming practices are known to alleviate the native effect of agriculture on soil insects. Soil insect abundance was examined in a variety of organic farms and in natural forest in northern Thailand using pitfall traps. More than 7,000 insects were collected and sorted to order. Soil insect abundance varied significantly with season, treatment, and agricultural crop. Insects were most abundant in Asian pear (AP), hill evergreen forest (HF), Chinese teas (CT), strawberries (ST), Asian maple trees (MT) and vegetables for human consumption (VH). Collembola were most abundant in most treatments, and ants were disproportionately common in samples from treatments with trees. There were more insects in the wet season than in the dry season in all treatments. Collembola, Orthoptera, Coleoptera and Hymenoptera differed significantly among different treatments, but Diptera did not. Their conclusion was that the abundance of soil insects at a site in northern Thailand varied significantly with season, treatment, and agricultural crop. The rank order of insect abundance was: AP, HF, CT, ST, MT and VH. Eight insect orders were recorded, and Collembola was the dominant order in all treatments. The rank order of Collembola abundance was: HF, AP, CT, MT, ST and VH. Collembola, Orthoptera, Coleoptera, and Hymenoptera were significantly different among treatments while Diptera showed no difference. Except Collembola, ants (Formicidae) were the dominant ground insects under tree covers. Gryllidae is a major group of omnivorous scavengers which was commonly found feeding on the decaying leaves of vegetables. Insects were significantly more abundant in permanent trees than in annual crops and they were significantly more abundant in the wet season than in the dry season across all habitat types. Innocenti et al (2011) studied on Does substrate water content influence the effect of Collembola-pathogenic fungus interaction on plant health? A mesocosm study and concluded that the soil moisture seems, on the basis of the data, to be a factor able to influence the biocontrol ability of *P. armata* against *G. graminis* var. *tritici* disease. It could be interesting to verify also their result in relation to soil moisture. Therefore, generalisations about the effect of moisture on Collembola - fungi interactions should be made with caution since the complexity of these interactions. Muturi et al (2011) studied on Effect of integrated soil fertility management interventions on the abundance and diversity of soil Collembola in Embu and Taita districts, Kenya and their study has demonstrated the potential of organic soil amendments in enhancing edaphic soil Collembola as well as diversity due to the increased substrate niche for soil Collembola. However, dry conditions negatively affect the trend. Therefore, use of organic manure in agricultural fields would not only boost agricultural food production, but, also sustain soil Collembola which are important in nutrient cycling. Souza et al (2011) worked on differential effects of two dominant plant species on community structure and invasibility in an old Weld ecosystem. According to them, if the biomass of subdominant species increases, but the biomass of dominant species does not decrease, then overall biomass has to be higher when herbivores are present. But they found no effect of herbivores on total biomass or on the biomass of dominant species. One possibility is that herbivores could have reduced the biomass of particular dominant species (such as *Solidago altissima*), which has an especially strong effect on the biomass of subdominant species in this system.

Materials
&
Methods

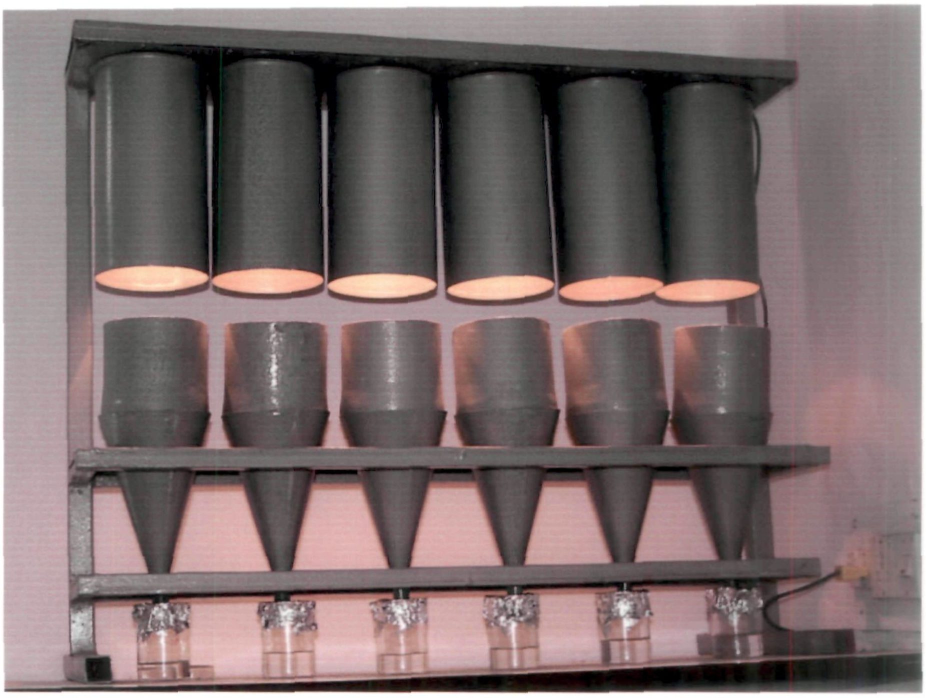


Figure 1a: Extraction Assembly (Tullgren Funnel)

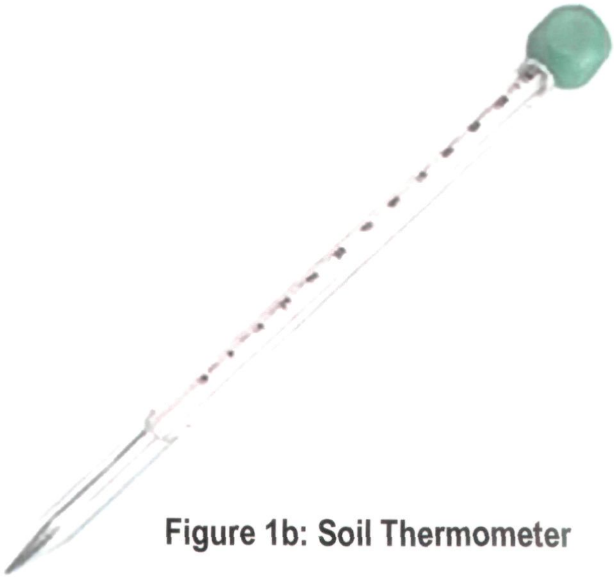


Figure 1b: Soil Thermometer

Figure 1c: Corers

Figure 1d: Boring Tool (For the purpose of removing soil)

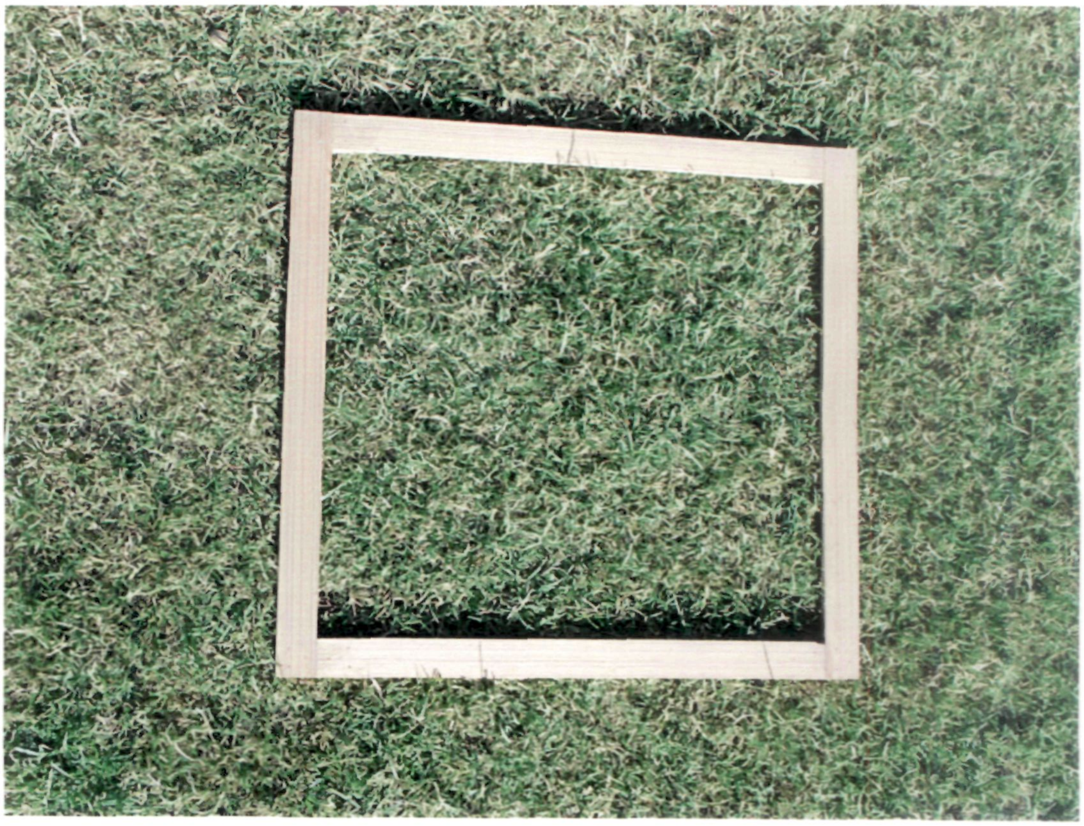


Figure 1e: Quadrant Sampler (1.5 m x 1.5 m)

MATERIALS AND METHODS

Methods of Sampling

The most commonly adopted method, especially among the more recent workers, involves the use of some kind of boring tool for the purpose of removing soil. Glasgow (1939) used a borer consisting of a galvanized iron pipe (34.29 cm long and 8.13 cm internal diameter) with its lower edge sharpened. The barrel was pushed down the soil by means of attached handle and foot rest; and when with drawn it removed the sample of 51.53 cm sq in area. A vertical slit 1.27 cm wide at the lower end of the barrel, facilitated the removal of the sample, but it would probably be difficult to remove the soil from such an implement in undisturbed condition. Salt and Hollick (1944), Salt et al (1948) and Salt (1952) used a standard "wire worm barer", which is made up of a metal cylinder 10.16 cm in diameter and about 20.32 cm deep with three large pistons used to eject the sample, cause considerable compression of the sample. Macfadyen (1953) took undisturbed soil samples by pressing small stainless tubes directly into the soil. Each tube was 5 cm long and 3.75 cm in external diameter and was driven into the soil by means of a detachable handle. The tube together with the enclosed soil was placed in the extraction apparatus so that the soil structure remains undisturbed.

A modified instrument originally described by Dhillon (1964). The apparatus consisted of a steel tube 60 cm long with an internal diameter of 5 cm. The upper end of tube was fitted with a circular handle of 30 cm diameter, resembling the stiering of a car, while the lower end of the tube was provided with a circular steel cutter 1 cm deep. The inner face of the cutter was vertical while the outer one was oblique to form a sharp cutting edge.

In the present investigation, a circular corer sampler based on the principle of O'Coner (1957) was used to avoid the casualty of delicate soil fauna but a slight modification was made in the corer that it was not split throughout its length; instead the corer was single tube of 7 cm internal diameter. The tube at its rear end bore a cutting edge. To facilitate its rotational movement, the upper end of the tube was fitted with a handle. In the sampler ten iron rings were inserted to get an idea of the depth from which the sample was to be taken. An iron pusher was inserted throughout the length of the handle of the sampler. After each operation, the cutting edge was detached and the rings were pushed down through the pusher (Figure 1c, 1d).

In the present study the author has collected the samples from mineral soil and litter.

1. **Litter**: Four samples of litter in a month were collected from each sampling site. (Mango Orchards and Teak Plantation). The amount of litter from the sampling sites was measured by quadrates (Figure 1c) of one-fourth of a square meter and the total area being 250 square meters.

2. **Mineral soil**: The soil samples were taken from a depth of 10 cm with the help of a corer as modified by Averbach and Crossely (1960). For vertical distribution studies, each sample obtained from 10 cm depth was divided into two sub-samples i.e. upper 0-5 cm and lower 5-10 cm.

Extraction of soil fauna

The extraction of microarthropods by Berlese funnel method has been used in the past by many investigators. One important early change in the funnel method was modification in which he substituted a heated water bath placed over and around the sample container, for the hot water jacket of the original apparatus.

Tullgren (1918) first used an electric bulb suspended above the tray so as to add the stimulus of light in order to drive the animals downwards in the funnel. Since then the Tullgren funnel have been improved and improvised by a number of authors Ford (1937), Haarlov (1947), Balogh (1958), Kevan (1962), and Murphy (1962).

Ford (1937) employed an apparatus, which consisted of a battery of 12 Tullgren funnels, the heat being suspended by electrically heated resistance were placed in cylinder on the chimney resting on each funnel. Hammer (1944) introduced the practice of placing undisturbed samples in the funnel in an inverted position rather than breaking the samples apart. Haarlov (1947) modified the funnels so as to prevent the condensation of moisture in them. Macfadyen (1953) combined these developments into a compact set of small funnels in order to produce a high gradient of temperature and humidity in the samples. With the growth of interest in Soil Zoology modifications in the method of extraction have been suggested from time to time by many workers such as Balogh (1958), Kevan (1962), Murphy (1962), Nef (1962), discussed the role of desiccation and temperature on the telegram funnel behavior type extractor. In the opinion of Macfadyen (1962) the sampling and extraction method to be used in a research project must be selected in accordance with the nature of the problem. In the present investigation, the dynamic extraction method was used. This method is based on the principle of the use of the stimuli which drive the animals out of their medium and the efficiency of the method largely depends upon animal behavior, changes in climate, moisture etc. The present worker has used a battery of 4 split funnel composed of three parts: (Figure 1a).

1. A bulb covered with a aluminum shade
2. An aluminum vessel with a sieve at its base
3. An aluminum funnel

The vials containing 70% alcohol and few drops of glycerol were placed beneath each funnel. An illumination with electric bulb of 15 watts was provided to each funnel. The litter and soil in the rings were exposed for 36 – 72 hours. The intensity of illumination was controlled through a regulator. The intensity of illumination was gradually increased with the time of exposure. Initially the intensity was low and after every 12 hours, intensity was gradually increased. A stereoscopic binocular microscope was used for counting of insects and mites and later on insects were separated from mites and preserved in 70% alcohol. Some of the insects were mounted in polyvinyl alcohol which was prepared by the following method:

Polyvinyl alcohol	:	30 gms
Distilled water	:	300 cc

Both were boiled in water bath for complete dissolution, to this solution 10 cc of glycerin and 10 cc lactic acid was added.

Mites were macerated in lactic acid with slight heat and were mounted in Hoyer's Medium.

Composition of Hoyer's Medium

Distilled water	-	50 cc
Gum Arabic	-	30 gm.
Chloral hydrate	-	200 gm.
Glycerin	-	20 cc

Small and light cover glasses were used for mites in order to save the specimen from crushing.

Larger insects and insect larvae were simply dehydrated by the usual methods and were mounted in DPX. Before mounting, the insects of darker colour were treated with cedar wood oil to impact transparency to these insects. The sides of the cover glasses over the slides were sealed with ordinary nail polish as to avoid evaporation of the mountant.

Mechanical Analysis

It has been done by the Hydrometer method (Piper, 1942) as per the following procedure:

Procedure:

A given quantity of air dry soil equivalent to 100 gm of oven dry soil was transferred to 100 ml graduated tall cylinder 200 ml of water and 15 ml of 0.5N sodium oxalate solution were then added. After thorough shaking the suspension was diluted to 1 liter by distilled water. The percentage of silt and clay in suspension was determined by nothing the hydrometer reading 5 minutes after the commencement of sedimentation and the percentage of clay from the hydrometer reading after 5 hours sedimentation. To record these readings accurate, the hydrometer was carefully introduced into the suspension 20-30 seconds before the predetermined time, when the temperature of the suspension differed markedly from 10-20^{0}C, a correction to the scale reading was made by adding 0.3 degree units for every degree about 19.4^{0}C or substracting the same amount for each degree below 19.4^{0}C. The values so determined would correspond directly to the percentage of silt and clay in the oven dry soil provided a 100 gm sample was taken. The data obtained in respect of mechanical analysis were mentioned in table 2.

Analysis of edaphic factors

For this purpose, the soil samples were cored from the same plots from where the soil samples were collected for population analysis. Various edaphic factors such as temperature, soil moisture, hydrogen ion concentration, relative humidity, content of organic carbon, organic matter, available nitrogen phosphate and potash have been analyzed by standard laboratory methods as discussed below:

Temperature

Temperature of the soil was measured by directly inserting the soil thermometer into the soil upto 7 cm. the soil thermometer used in present investigation has been shown in photograph. (Figure 1b)

Relative Humidity

Relative humidity of the surface of the soil has been determined with the help of a Dial hydrometer.

Hydrogen ion concentration (pH)

To 100 ml of double glass distilled water taken in a glass bottle 20 gm of fine earth was added. The bottle was stoppered and shaken in a mechanical shaker for an hour; after which the solution was transferred to a glass beaker and its pH value was examined with the pH meter.

Before taking the reading of pH of soil solution the instrument was standardized each time with a standard Backmen Buffer Solution to avoid the instrumental error.

Water Content

The absolute content of water which has an impact on the activities and distribution of the animals generally exists in variable quantity rising to a maximum after heavy rain and falling rapidly during the hot months. For this reason, sample for the determination of water content were never collected immediately after heavy rains.

Content of water has been determined here by a method described by Dowdeswell (1959).

Procedure

Soil samples after collection were kept in a tray for 24 hours for preliminary air drying. It was then crushed in mortar and pastle and passed through fine sieve no. 80 to obtain fine powder of earth. Ten grams of this air dried fine earth was taken in an evaporating dish and kept in a hot air oven at about $105^{0}C$ for an hour. It was then cooled in desiccators and again weighed. This was repeated at regular intervals until the weight become constant. The loss in weight expressed in percentage represented the moisture derived from both hygroscopic water some of the capillary water.

Potassium

Principle

Water soluble Potassium in the soil can be determined by precipitation in water solution as cobaltinitrite. The amount of potassium in the precipitate is determined colorimetrically. The method requires removal of ammonium ions present in the sample.

Reagents used

1. Sodium hydroxide (10%)
2. Hydrochloric acid (1 N)
3. Nessler reagent
4. Phenolphthalein indicator
5. Potassium hydroxide (6 N)
6. Hydrogen peroxide (3%)
7. Potassium bicarbonate (saturated)

Procedure:

Precipitating Reagent

20% sodium cobaltinitrite solution was dissolved in 20 g of sodium cobaltinitrite $Na_3Co(NO_2)_6$ in distilled water (80ml) and made the volume to 100 ml. After standing for 4-5 hours it was filtered through a retentive paper to remove traces of insoluble matter. The solution was kept in stopper bottle, at 5°C.

Solvent for Potassium

Acetic acid was used as a solvent for potassium. 4% formaldehyde was also added to remove traces of ammonia from interfering through co-precipitation with potassium.

Standard potassium Chloride Solution

0.1907 g dried KCl was dissolved in water and transferred it to the volumetric flask to make the total volume to 500ml. Each ml contains 0.2 mg of K.

Removal of Ammonium

Two to three drops of phenolphthalein indicator was added to the beaker containing potassium solution. Then 10% NaOH solution was added drop wise until the colour of phenolphthalein turns red. The solution was evaporated to dryness to remove last traces of ammonia. When the evaporation is complete, 2 ml of 1 N HCl was added and also a drop of this HCl solution to a spot plate and test for ammonium ion with Nessler reagent.

Preparation of Solution

The beaker was cooled and about 15 ml of the solvent for potassium (i.e., acetic acid containing 4% formaldehyde) was added. The solution was filter through a dry filter paper into a 50ml conical flask which is then stoppered. The amount of potassium in the precipitate is determined colorimetrically.

Colorimetric Method for determination of amount of potassium in the precipitate

20% solution of sodium cobaltinitrite was added to the beaker containing solution of potassium salt at a constant temperature. The precipitate formed was washed several times with 70% ethanol. The precipitate was then dried for 5 min at 100 to 110^{0}C. The precipitate was dissolved in 6 N HCl and the solution was transferred to a tube bearing calibration mark and colorimetrically standardized. After this 1.5 ml. of 6 N KOH solution was added. Then 0.5 ml of 3% H_2O_2 was added in the tube. The contents mixed thoroughly. In case the brown precipitates begin to form 6 N HCl was added drop wise to clear the solution. Finally 15 ml of $KHCO_3$ was added and made the volume upto the standard mark on the tube with water and the colour was measured in the colorimeter or at 620 nm with spectrophotometer. Also blank solution was employed for 100% transmission for setting of the colorimeter. The colorimetric readings was referred to the calibration curve (drawn by taking standard solutions of KCl) to find K in the test sample.

Organic Carbon estimation by Walklay – Black method

Principle

The soil is digested with potassium dichromate ($K_2Cr_2O_7$) and conc. H_2SO_4 making use of dilution of heat of conc. H_2SO_4. Excess dichromate is not reduced by the organic matter of soil in back titration with ferrous ammonium sulphate ($FeSO_4$) $(NH_4)_2$ SO_4.

$$K_2Cr_2O_7+4H_2SO_4 = K_2SO_4+Cr_2(SO_4)_3 +4H_2O+3O$$

This nascent oxygen oxidizes carbon of the soil to carbon dioxide.

Procedure

Soil sample weighing 0.5 gm were placed in a 500 ml conical flask after passing through 0.2 mm (80 meshes/inch) non ferrous sieve 10ml of 1N $K_2Cr_2O_7$ solution was pipetted on to the soil, the two were mixed by swirling the flask, then 20ml of conc. H_2SO_4 were added and mixed by gentle rotation for 1 minute to ensure complete contact of the reagent with soil. The mixture was allowed to stand for 20-30 minutes. A standardization blank (without soil) was run in the same way.

Back Titration

The solution was diluted to 200 ml with water 10ml of 85 % orthophosphoric acid (H_3PO_4), 0.2 gm of NaF and 30 drops of diphenylamine indicator was added. The solution was back titrated with 0.5N ferrous ammonium sulphate solution delivered from a burette. The solution in flask which turned turbid blue after the addition of the indicator, gradually assumed green colour and at the end point, the colour became brilliant green after adding a drop of ammonium sulphate. The results were calculated by the equation given below:

$$\%\,O\,M = 10(1\text{-}T/S) \times 1.34$$

S = Standardization blank titration, ml Ferrous solution

T = Sample titration, ml ferrous solution

a. The standard 1N $K_2Cr_2O_7$ was prepared by dissolving 49.04 gm in water and the solution was diluted to one litre.

b. 0.5N solution of ferrous was prepared dissolution of 19.61gm of Fe $(NH_4)^2$ SO_4. $6H_2O$ in 8 ml of water. To this solution 20 cc of conc. H_2SO_4 was added. The solution was diluted to one litre.

Phosphate

Phosphate normally occurs in small quantities but none the less, their determination may be important in the study of a rapidly changing environment. In the present investigation molybdenum blue test as described by Dowdeswell (1959) was employed to estimate the phosphate content of the soil. The molybdenum blue test provided as ready means of colorimetric estimation involving minimum of time and apparatus.

Principle:

Orthophosphate and molybdate ions condensed in acidic solution to give molybdophosphoric acid which upon selected reduction produces a blue colour due to molybdenum blue of uncertain composition. The intensity of blue colour is proportional to the amount of phosphate initially incorporated in heteropoly complex which is thought to be formed by coordination of molybdate ions within phosphorous as the central coordinating atom, the oxygen of the molybdate radicals being substituted for PO_4.

$$H_3PO_4+12H_2MoO_4\ H_3P(Mo_3O_{10})_4+12H_2O$$

Procedure

To 100 ml of soil extract taken in a conical flask, 1ml of molybdate sulphuric acid reagent and 5 drops of 2.5% stannous chloride solution were added. It was mixed well and on being allowed to stand for 10 minutes. It resulted to blue colour. Similar treatment was followed with 100 ml of standard phosphate solution (with 1ppm phosphorus).

Standard curve was plotted by measuring the optical densities of the series of gradual concentration derived from the original standard at a wave length 660 nm in a spectro photometer (Bausch and Lamb). The optical density of the unknown material was compared against the standard curve and its concentration, phosphate was thus obtained being expressed as parts of phosphorous per million or as available phosphate as commonly used in agricultural practices.

Available Nitrogen

Available nitrogen occurs in small quantities which ultimately change into nitrate, their determination may be important in the study of a rapidly changing environment. In the present investigation Alkaline permanganate method was employed to estimate the available nitrogen in the soil.

Principle

A known weight of the soil is mixed with excess of alkaline $KMNO_4$ solution and distilled. Ammonia gas formed is absorbed in a known volume of standard acid excess of which is titrated with standard alkali using methyl red as the indicator.

Alkaline permanganate has been used as an extracting reagent for the characterisation of the nature of nitrogen in organic manures and this forms the standard AOAC procedure for the estimation of active nitrogen.

This method, however, is the quickest of all other methods for the estimation of available nitrogen and has been found to work well even in Indian soils.

Procedure

Take 20gm of the given soils sample in distillation flask and add 20ml of water. Now add 100ml of 0.32% $KMNO_4$ solution and 100 ml of 2.5% sodium hydroxide solution and immediately fit it up in the distillation apparatus. Pipette out 20 ml of 0.02N sulphuric acid in a conical flask and dip the end of the delivery tube in it. Distil ammonia gas from the distillation flask and collect about 30ml of the filtrate. Now add 5 drops of methyl red indicator and titrate with 0.05 N sodium hydroxide.

Procedure for Isolation of Soil Fungi

One gm soil sample from each site was suspended in 99 ml of sterilized distilled water. It was thoroughly shaken and further dilution was made so as to give finally a dilution 1: 104. One ml portion from the final dilution were transferred aseptically to sterilize glass Petri dishes, and one tube of Czapeks Agar medium was added separately to each Petri dish. Each sample to which Czapek's agar medium was added was replicated three times. Petri dishes were rotated with the object of mixing uniformally the sample and media. These were labeled and kept in inverted position in the incubator at 30°C. The colonies of fungi, which appeared after 4 days of incubation, were counted and studied for their morphological characteristics.

Identification of fungi isolates

On the basis of colony characteristics and direct examination of mycelia and fruiting bodies the fungal isolates were identified up to the generic level with the help of "A manual of fungi".

Method of preparation of Czapek's Agar Medium

$K_2 H PO_4$	=	1 gm
$NaNO_3$	=	2 gm
$MoSO_4.7H_2O$	=	0.5 gm
K_{61}	=	0.5 gm
Malt Agar	=	20 gm
Distilled water	=	1000 ml

The medium was adjusted to pH = 7. Aliquots measuring 10 ml were transferred to the culture tubes, which were plugged with cotton and sterilized at 15 1bs pressure per square inch for half an hour.

STATISTICAL ANALYSIS

Mean, standard deviation, SEM, correlation (r), Regression (y) and Analysis of variance (ANOVA) were calculated according to the formula described by S. Prasad (2003). Species diversity (H) and Evenness (J) were calculated by Shanon and Wiener diversity index (1949) and Evenness (Pielou, 1966) based on the following formula:

Shannon and Wiener diversity index (1949):

$$H' = -\sum_{i=1}^{N} P_i \log_2 P_i$$

Where,

H'	=	species diversity
P_i	=	n_i/N is the probability of an individual to belong to a species.
N_i	=	no of individual in i^{th} species
N	=	Total number of individuals in samples.
S	=	Number of species.

Evenness (Pielou, 1966):-

$$J = H' / H_{\max}$$

Where,

J	=	Eveness
H'	=	Diversity index described by Shannon wiener equation.
H_{max}	=	$\log_2 S$
S	=	Number of Species.

Results

Sampling Site: Teak Plantation

Sampling Site: Mango Orchards

Sampling Site: Unarable Land

Sampling Site: Wheat Field

RESULTS

The soils of Aligarh district

Aligarh covers an important area among the district of Uttar Pradesh (India). The district lies towards north of the Gang-Yamuna doab within the parallels $27^{0}29'$ and $28^{0}1'$ north latitude and $77^{0}29'$ and $78^{0}38'$ east latitude. Aligarh district acquires an area of 1950 sq. miles. Its alluvial deposits have a gentle slope from north-west to south-east. There are several natural depressions apart from those formed by the river, valleys and drainage lines. Topographically the district presents a trough like appearance with high Ganga and Yamuna banks at its extreme rims. It has a semi-desert type of climate which means annual air temperature of $26.7^{0}C$ and annual rainfall of 72.64 mm. summer heat raises the temperature upto $42^{0}C$ with relative humidity ranging between 22 – 95% and dew point 8 – 28 (Table 1a, 1b). A fluffy layer of salts, about 2.5 cm. thick, is observed on the surface during dry months, water tabel fluctuates between 0.2 and 2.0 m. depth.

The soils of Aligarh district are alluvial with little leaching and considerable accumulation of salts on the surface. The alluvial beds varying from olive brown to ash gray in colour, very strongly alkaline to weak alkaline in nature, pass through the successive layers of sand, sandy silt and clay with occasional compact beds of an indurated character (Table 2).

Sites of the study

In order to ascertain the qualitative and quantitative composition of soil inhabiting insects and mites, the area in and around the campus of Aligarh Muslim University, Aligarh has been selected.

Four experimental plots were identified, namely Mango orchard, Teak plantation, Unarable land and an agricultural plot wheat crop cultivated mainly. The four experimental plots were selected on the basis of: (1) the type of vegetation, (2) human interference in the form of management techniques, (3) different type of litter, (4) different microclimatic conditions.

These four sites are likely to be a simple one in view of the several limitations imposed by the physical factors in the environment and the present study was designed, not only to identify the principal faunal components of each site but also to investigate the distribution patterns and population dynamics in relation to certain well defined abiotic factors such as temperature, moisture, organic carbon, available nitrogen etc. in these four sites which are very important factor for the soil microarthropods population. The activity of soil microarthropds is very significant for the fertility of soil. Therefore, this was the main reason for choosing these sites for the ecological study of soil insects.

DESCRIPTION OF THE SITES

Mango Orchards

This site (Mango Orchards) is situated near the University Health Centre. The area of the orchard is a selected area and does not experience much human interference, occasionally the cattles seen to roam about in search of fodder. Arboreal inhabitants are too many. There are approximately 50 trees of mango. *Magnifera sp:* which shed their leaves once in a year. It was difficult to find a good amount of litter deposition since much of the dried leaves, especially during summer months, were very little in amount as to collect them as a sample. The litter though negligible was entirely composed of Mango leaves, decayed slowly and underwent decomposition only during rainy season. At this site, the impact of vegetation was more conspicuous. The mango trees were thinly pruned once in a year and the pesticide treatment specially for termites is done before and after monsoon months.

Teak Plantation

Plantation is a part of agroforestry planed by the government to serve the ecosystem and create a green belt. This selected site has Teak Plantation (*Tectona grandis*) A.M.U. campus has teak plantation at different location along the side of various departments. The idea was to beautify the campus as well as to enhance the fertility of soil. The leaves of *Tectona grandis* are thick, broad and dark green in colour. This may during blooming period (march - December) the plantation areas gets a thick green belt look and becomes a refuge for all the birds big and small, cattles, dogs and passer bys. The plantation area as it is within the university campus along the main road it is attached by the vehicular pollution along with the human intervention permanently, as it is used as a short cut passage. Secondly to maintain the quality of the timber the trees are pruned regularly. This land and garden department takes care of the areas by regularly ploughing both manually and mechanically, sprays of insecticides and pesticides are also done as and when required. Thirdly litter deposition was observed only during spring (end January - February). Good amount of litter gets deposition during these months and in rest of the months the litter was less in amount. Tree shade does not allow the surface of this ecosystem to become green. Hence presence of fungus is seen only in the months of monsoon on the soil surface.

Unarable land

The site is situated at Zakir bagh behind the faculty of arts near the Masjid surrounded by very few trees. The site is an unarable patch of land with undulating surface and experienced much human and cattle interference. The site is not managed and is a part of the campus. This place is used by students, employees and passer-bys regularly. Also if the stray animals make their way through, deposition of cow dung is also observed. The only source of water is sewage water from the Masjid in this field, so the soil remains moist for most of the time near the masjid. It is believed that the unarable land as the pieces of land which is not managed either by agriculturist or horticulturist becomes barren, or, remains barren, but sometimes if cultivated proves to be a green land. Keeping this view of ecologist we selected this site and sampled it regularly to assess its faunal population.

Wheat Field

This selected site have some degree of agricultural operations and field manuring with cowdung. The vegetation of the field included the wheat crop from the month of December to April and in the remaining period this field was entirely unused. This field is located near the University Botanical garden (Formally University Fort) which has an interesting topography. It is surrounded by very few trees, wild grasses and rarely grazed by animals. It is under manual tillage and mechanical tillage and use of pesticides is done regularly. Chemical as well as organic manure is used during the wheat cultivation period. This site was selected to assess the impact of tillage, chemical and organic fertilizers on the population of the soil microarthropods. Also we tried to analyze the population dynamics during and after harvesting.

VARIATION AND SEASONAL FLUCTUATION OF PHYSICO-CHEMICAL FACTORS AT DIFFERENT SITES

The mechanical analysis of soil samples from all the sites revealed that the composition of the soil comprised clay, silt and sand in varying proportions. The soil of the entire region is olive brown to ash gray in colour (Table 2). Monthly variation in different physico-chemical factors has been described site-wise below:

SITE – MANGO ORCHARDS

Soil Temperature

The maximum soil temperature was recorded in the months of March 30 °C, April 30 °C, May 30 °C, and June 30 °C of sampling year 2008, and June 41 °C of sampling year 2009. Minimum soil temperature was recorded in the months of December, February and December, 17°C in December, 2008, and 16°C in February December, 2009.

Soil Moisture

Maximum soil moisture was recorded in the months of November 3.52% of sampling year 2008, January 3.42% of sampling year 2009. Minimum soil moisture varied between 1.01% - 1.32% in 2008 and 0.5% - 0.7% in 2009.

Soil pH

The range of soil pH did not show much variation in both the sampling years. It was varied 8.4 - 9.1 in the year of investigation.

Soil Organic Carbon

The amount of soil organic carbon was found to be maximum in September and August. It was 0.95% in 2008 and 1.16% in 2009. Minimum percentage of organic carbon in the months of July, 2008 and June, 2009 it was recorded 0.48% and 0.47%.

Soil Organic Matter

The Maximum amount of soil organic was recorded in the months of September, 2008 and August, 2009. It was 1.63% and 1.99%. Minimum percentage of organic matter in the months of July, 2008 and June, 2009 it was found 0.83% and 0.8%.

Available Nitrogen

Available nitrogen in soil was maximum in the months of September, 2008 and August, 2009 it was 331 ppm and 375 ppm. Minimum observed in the months of July, 2008 and June, 2009 it was recorded 216 ppm and 209 ppm.

Soil Phosphate

The phosphate content of the soil was highest in the months of March, 2008 and November, 2009. It was 7.52 ppm and 16.77 ppm. The lowest amount was in the months of September, 2008 and June, 2009. It was found 4.03 ppm and 6.61 ppm.

Soil Potassium

Maximum potassium content of soil was recorded in the months of July, 2008 and January, 2010.It was 616 ppm. Minimum potassium content of soil was recorded in the months of December, 2008, and April, May, 2009. It was 224 ppm and 168 ppm.

[The above result obtained is recorded in Table 3a, 3b and in Figure 10a (i, ii, iii, iv, v)]

<u>SITE – TEAK PLANTATION</u>

Soil Temperature

The maximum soil temperature was recorded in the month of April 30.5 °C of sampling year 2008, and June 31.5 °C of sampling year 2009. Minimum soil temperature was recorded in the months of December, and January, 20°C in December, 2008, and 15°C in January, 2009.

Soil Moisture

Maximum soil moisture was recorded in the months of December 3.84% of sampling year 2008, January 4.28%, February 4.28% of sampling year 2009. Minimum soil moisture was 1.22% in September, 2008 and 0.91% in October, 2009.

Soil pH

The range of soil pH did not show much variation in both the sampling years. It was varied 8.2 - 9.6 in the investigation years.

Soil Organic Carbon

The amount of soil organic carbon was found to be maximum in March and April. It was 0.83% in 2008 and 0.74 in 2009. Minimum percentage of organic carbon in the months of December, 2008 and March, 2009 it was recorded 0.2% and 0.09%.

Soil Organic Matter

The Maximum amount of soil organic was recorded in the months of March, 2008 and April, 2009. It was 1.42% and 1.27%. Minimum percentage of organic matter in the months of December, 2008 and March, 2009 it was found 0.34% and 0.16%.

Available Nitrogen

Available nitrogen in soil was maximum in the months of March, 2008 and April, 2009 it was 289 ppm and 276 ppm. Minimum observed in the months of December, 2008 and March, 2009 it was recorded 93 ppm and 43 ppm.

Soil Phosphate

The phosphate content of the soil was highest in the months of September, 2008 and November, 2009. It was 5.96 ppm and 13.44 ppm. The lowest amount was found in the months of May, 2008 and October, 2009. It was found 3.01 ppm and 7.41 ppm.

Soil Potassium

Maximum potassium content of soil was recorded in the months of April, October, November, 2008 and March, 2009.It was 504 ppm. Minimum potassium content of soil was recorded in the months of September, 2008, and April, May, June, September, October, December, 2009. It was 336 ppm and 392 ppm.

The above result obtained is recorded in Table 4a, 4b and in Figure 10b (I, ii, iii, iv, v)

SITE – UNARABLE LAND

Soil Temperature

The maximum soil temperature was recorded in the months of July 33.5 °C of sampling year 2008, and July 35 °C, August 35 °C of sampling year 2009. Minimum soil temperature was recorded in the months of December 18°C, 2008, and 18.5°C in January, 2009.

Soil Moisture

Maximum soil moisture was recorded in the months of July 4.28% of sampling year 2008, January 4.17% of sampling year 2009. Minimum soil moisture was 1.22% in May, 2008 and 0.3% in October, 2009.

Soil pH

The range of soil pH did not show much variation in both the sampling years. It was varied 9.1 - 9.9 in the year of investigation.

Soil Organic Carbon

The amount of soil organic carbon was found to be maximum in April and May. It was 0.83% in 2008 and 0.81 in 2009. Minimum percentage of organic carbon in the months of September, 2008 and January, 2009 it was recorded 0.44% and 0.65%.

Soil Organic Matter

The Maximum amount of soil organic was recorded in the months of April, 2008 and May, 2009. It was 1.42% and 1.4%. Minimum percentage of organic matter in the months of September, 2008 and January, 2009 it was found 0.75% and 1.11%.

Available Nitrogen

Available nitrogen in soil was maximum in the months of April, 2008 and May, 2009 it was 289 ppm and 284 ppm. Minimum observed in the months of September, 2008 and January, 2009 it was recorded 196 ppm and 223 ppm.

Soil Phosphate

The phosphate content of the soil was highest in the months of May, 2008 and November, 2009. It was 12.04 ppm and 12.2 ppm. The lowest amount was in the months of October, 2008 and August, 2009. It was found 7.09 ppm and 5.85 ppm.

Soil Potassium

Maximum potassium content of soil was recorded in the months of May, 2008 and August, 2009.It was 728 ppm. Minimum potassium content of soil was recorded in the months of September, 2008 and May, June, 2009. It was 336 ppm and 392 ppm respectively.

The above result obtained is recorded in Table 5a, 5b and in Figure 10c (I, ii, iii, iv, v)

SITE – WHEAT FIELD

Soil Temperature

The maximum soil temperature was recorded in the months of June 32 °C of sampling year 2008, and May 35 °C of sampling year 2009. Minimum soil temperature was recorded in the months of December 17.5°C, 2008, and 19°C in November, December, 2009.

Soil Moisture

Maximum soil moisture was recorded in the months of July 3.22% of sampling year 2008, October 3.84% of sampling year 2009. Minimum soil moisture was recorded in the month of May 1.22% in 2008 and February 0.4% in 2010.

Soil pH

The range of soil pH did not show much variation in both the sampling years. It was varied 9.0 - 9.8 in the year of investigation.

Soil Organic Carbon

The amount of soil organic carbon was found to be maximum in October, 2008 and August, 2009. It was 0.72% and 0.71% respectively. Minimum percentage of organic carbon was observed in the months of May 0.23% in 2008 and January 0.23% in 2010.

Soil Organic Matter

The Maximum amount of soil organic was recorded in the months of October, 2008 and August, 2009. It was 1.24% and 1.22%. Minimum percentage of organic carbon was observed in the months of May 0.39% in 2008 and January 0.39% in 2010.

Available Nitrogen

Available nitrogen in soil was maximum in the months of October, 2008 and August, 2009. It was 185 ppm and 185 ppm. Minimum observed in the months of May, 2008 and January, 2010. It was recorded 107 ppm and 107 ppm respectively.

Soil Phosphate

The phosphate content of the soil was highest in the months of August, 2008 and March, 2009. It was 11.82 ppm and 14.04 ppm respectively. The lowest amount was found in the months of May 9.12 ppm in 2008 and June 6.5ppm in 2009.

Soil Potassium

The range of potassium content of soil did not show much variation in both years of sampling. It was varied 392 – 560 ppm.

The above result obtained is recorded in Table 6a, 6b and in Figure 10d (i, ii, iii, iv, v)

VARIATION AND SEASONAL FLUCTUATION IN THE FAUNAL POPULATION OF THE SITES

SITE – MANGO ORCHADS

Mineral Soil Population : (0-5 cm depth)

INSECTA – The insects sampled from the soil of this site belong to both the sub-classes. The pterygote population was represented both by adult and larval forms. The pterygote insects belonging to orders: Coleoptera and Diptera were represented by their *larval forms belonging to family – Scarabaeidae, Elateridae and Tipulidae respectively.* The apterygote insects were dominated by the collembolans which belong to family – Poduridae, Entomobryoidae and Onychiuridae. The order Diplura was represented by Japyx sp. The result obtained is recorded in Table 7a, 7d, 8a, 8d and in Figure 11d, 11g, 15d, 15g.

ACARINA – The mite population of this site belonged to Prostigmata, Mesostigmata and Cryptostigmata While considering the relative number mites present at this site Prostigmata seemed to be the dominant one. The result obtained is recorded in Table 7g, 8g and in Figure 11j, 15j.

5-10 cm depth

INSECTA – The insectan population of deeper layer was rich in pterygote adults but the pterygotan larval forms were very few and represented by dipterans, isopterans and coleopterans. The Scarabaeidae, Elateridae, Tipulidae larvae were collected for the two consecutive years. The deeper layer apterygotes were Collembola and Diplura. The collembolans were represented by members of family Poduridae, Entomobryoidae, and Onychiuridae. Diplura was of family Japygidae. The result obtained is recorded in Table 7b, 7e, 8b, 8e and in Figure 11e, 11h, 15e, 15h.

ACARINA – The Mite population decreased with the increase in depth. The total acari were represented by sub-order Cryptostigmata, Prostigmata and Mesostigmata. The result obtained is recorded in Table 7h, 8h and in Figure 11k, 15k.

Litter

INSECTA – Among the pterygote population coleopterans larvae and adults were frequently sampled in both the two years of sampling. Adult dipterans and hymenopterans (48, 64 and 05, 06) were also collected. Larval form of family Scarabeidae was dominated.

The apterygote population comprised of Collembola and Diplura. Family Poduridae was the dominant (28 in the first year and 242 in the second year) among the families Isotomidae, Sminthuridae, Entomobryoidae, Onichiuridae and Japygidae. The result obtained is recorded in Table 7c, 7f, 8c, 8f and in Figure 11f, 11i, 15f, 15i.

ACARINA – The acarina population of litter consisted of members of the sub order Cryptostigmata, Prostigmata and Mesostigmata. Prostigmata was collected in a good number and the Cryptostigmata was very few in numbers. The result obtained is recorded in Table 7i, 8i and in Figure 11l, 15l.

SEASONAL FLUCTUATION

The total number of Insects and Mites obtained from this site showed an irregular trend of fluctuation. During the sampling period ranging from March 2008 to February 2010 among the adult pterygotes, Isoptera Termitidae was maximum in July to September (monsoon months), minimum in April and more or less constant in December and January (Winter months). Same was the case with Hymenoptera: Formicidae. They exhibited a gradual increase from June and attained a peak in July to September followed by gradual decline. The larval forms of Carabidae and Elateridae and those of Diptera especially the Tipulidae were maximum in the monsoon months and minimum in summer and winter. The carabides were not collected in mostly months, and Elaterides were also not encountered from the soil samples of July to December for the total sampling period. The apterygote population was rich in the epigeal layer. Among the collembolans Poduridae, Entomobroidae and Onychiuridae were collected. Their number was maximum in the monsoon months and minimum in April to June. Their number increased with the onset of monsoon (July). Among the three representatives of collembolans, Poduridae seemed to be dominant as it was obtained in relatively large numbers in the both years of study. The order Diplura was represented by Japyx sp., their number increased during the months (May – August) coinciding with the peak of abundance of Collembola.

The Mite population of this site exhibited similar trends in population. Maximum numbers of mites were collected in the month of July and August for the both consecutive years. Among the three sub-orders collected Prostigmata was dominant. Cryptostigmata was collected in lesser number. Mesostigmata was collected in moderate numbers. They all showed February - June with the increase in depth the number of insects and mites collected was less. The pterygote population consisted of isopterans with a good amount were also collected which attained a peak in June to August and gradual decline towards winter months.

The collembolans were Poduridae, Entomobryoidae, and Onychiuridae. At this site though the collembolans exhibited more or more similar trend of fluctuation, Poduridae was the dominant species with maximum collection in January, 2010. Poduridae and Entomobryoidae exhibited an irregular trend throughout the sampling period. Japygidae the only Dipluran had a peak in September and minima in January to April of the both years.

The Mite population was collected in lesser number as compared to epigeal population. Prostigmata was dominant among Cryptostigmata, Mesostigmata. They all exhibited an irregular trend of fluctuation through out the period of investigation.

SITE – TEAK PLANTATION

Mineral Soil Population : (0-5 cm depth)

INSECTA – The pterygote population was represented in the form of adult and larval. In relationship to other insects, dipterans were numerous. The orders Coleoptera was represented by their larval forms belonging to family – Scarabaeidae and Elateridae.

The collembolans of the sub class apterygote insects were dominated which belong to family – Poduridae, Entomobryoidae and Onychiuridae. Family Poduridae were dominated at this site. The order Diplura was represented by Japyx sp. The result obtained is recorded in Table 9a, 9d, 10a, 10d and in Figure 12d, 12g, 16d, 16g.

ACARINA – The mite population of this site belonged to Prostigmata, Mesostigmata and Cryptostigmata While considering the relative number mites present at this site Prostigmata seemed to be the dominant one. The result obtained is recorded in Table 9g, 10g and in Figure12j, 16j.

5-10 cm depth

INSECTA – The insectan population of deeper layer was rich in pterygote adult but the pterygotan larval forms were very few and represented by dipterans, isopterans and coleopterans. The Scarabaeidae, Elateridae and larvae were collected for the two consecutive years. The deeper layer apterygotes were Collembola and Diplura. The collembolans were represented by members of family Poduridae, Entomobryoidae, and Onychiuridae. Diplura was of family Japygidae. Poduridae was the dominant among the families Isotomidae, Sminthuridae, Entomobryoidae, Onychiuridae and Japygidae (Table 9b, 9e, 10b, 10e and in Figure 12e, 12h, 16e, 16h).

ACARINA – The Mite population decreased with the increase in depth. The total acari were represented by sub-order Cryptostigmata, Prostigmata and Mesostigmata. The result obtained is recorded in Table 9h, 10h and in Figure 12k, 16k.

Litter

INSECTA – Among the pterygote insect the population of coleopterans larvae and adults were frequently sampled in both the two years of sampling. Adult dipterans and hymenopterans were also collected. A larval form of family Scarabaeidae was dominated. The apterygote population comprised of Collembola and Diplura. Family Poduridae was the dominant among the families Isotomidae, Sminthuridae, Entomobryoidae, Onychiuridae and Japygidae. The result obtained is recorded in Table 9c, 9f, 10c, 10f and in Figure 12f, 12i, 16f, 16i.

ACARINA – The acarina population of litter consisted of members of the sub order Cryptostigmata, Prostigmata and Mesostigmata. Prostigmata was collected in a good number and the Cryptostigmata was very few in numbers (17 in the first year and 06 in the second year). The result obtained is recorded in Table 9i, 10i and in Figure 12l, 16l.

SEASONAL FLUCTUATION

The total number of Insects and Mites collected from litter and soil showed an irregular trend of fluctuation. The litter inhabiting forms were found to be higher in number. Among the pterygotes, dipterans observed a peak in the months of July to October followed by a gradual decrease. The larval form was found very few in numbers throughout the sampling period. The collembolan population was the same approximately than that of the previous site (Mango Orchards), and because of an insulation provided by the litter cover and moisture they were found in all the months of the year. Among the collembolans the Poduridae was collected in a maximum number as compared with other species. Their number increased with the onset of January to April and attained a peak in March followed by gradual decrease. The minimum numbers of collembolans were collected in the months of May to October.

The Acarina population of litter was rich in its comparison. The mites collected were Cryptostigmata, Prostigmata, and Mesostigmata. The population curve of the species show that all the mites observed a July peak. The months of February to June showed a sharp decline in their number and more or less constant population curve was seen in winter months. The total number of insects and mites collected from the upper soil layers (0–5 cm) also showed an irregular trend in population fluctuation but the number of insects and mites were on a same scale as compared with the previous site (Mango Orchards).

Isopterans, Coleopterans and Dipterans were maximum in the months of July to September. Coleoptera showed a sharp decline in the month of November, throughout the sampling period. Collembolan and acarina population showed the same trend. Only Poduridae, Isotomidae, Sminthuridae, Entomobryoidae were collected with Poduridae being the dominant one with maximum number in March. Japygidae were collected approximately same in number as previous site (Mango Orchards). Among acari Prostigmata were dominated of the total epigeal population. The population curve of acarina shows Prostigmata to be dominated in July both the consecutive years. There was a sudden increase in the month of May attaining a peak in July to August and a sudden decrease in February. In the deeper layer the coleopterans species and larval forms of Scarabaeidae, Elateridae and Tipulidae through collected in lesser number exhibited a gradual increase from June, attained a peak in August and followed a gradual decrease.

Among the apterygote population Poduridae, Isotomidae, Sminthuridae, Entomobryoidae and Japygidae also followed the same trend, with peak in August. The winter population was more or less constant. Among acarina population Prostigmata was dominant with peak in July, followed by a decline in number. They all exhibited an irregular trend of fluctuation through out the period of investigation.

SITE – UNARABLE LAND

Mineral Soil Population : (0-5 cm depth)

INSECTA – The insects sampled from the soil of this site belong to both the sub-classes. The pterygote population was represented both by adult and larval forms. In comparison to other insects, Isopterans were numerous. The orders Coleoptera and Diptera were represented by their larval forms belonging to family – Scarabaeidae, Elateridae and Tipulidae. The apterygote insects were dominated by the collembolans which belong to family – Poduridae, Entomobryoidae and Onychiuridae. The members of Poduridae were dominated at this finding. The order Diplura was represented by Japyx sp. The result obtained is recorded in Table 11a, 11c, 12a, 12c and in Figure 13c, 13e, 17c, 17e.

<u>ACARINA</u> – The mite population of this site belonged to Prostigmata, Mesostigmata and Cryptostigmata While considering the relative number mites present at this site Prostigmata seemed to be the dominant one. The average mean population of all the three groups are 19.83, 17.08, 3.5 in 2009 and 45.17, 27 in 2010 respectively (Table 11e, 12e and in Figure 13g, 17g).

5-10 cm depth

<u>INSECTA</u> – The insectan population of deeper layer was rich in pterygote adult but the pterygotan larval forms were very few and represented by dipterans, isopterans and coleopterans. The Scarabaeidae, Elateridae, Tipulidae larvae were collected for the two consecutive years. The deeper layer apterygotes were Collembola and Diplura. The collembolans were represented by members of family Poduridae, Entomobryoidae, and Onychiuridae. Diplura was of family Japygidae. The members of Japygidae were very few in numbers. The result obtained is recorded in Table 11b, 11d, 12b, 12d and in Figure 13d, 13f, 17d, 17f.

<u>ACARINA</u> – The Mite population decreased with the increase in depth. The total acarii were represented by sub-order Cryptostigmata, Prostigmata and Mesostigmata. Cryptostigmata were very few in numbers. The result obtained is recorded in Table 11f, 12f, and in Figure 13h, 17h.

SEASONAL FLUCTUATION

The total number of insects and mites found from this site showed an irregular trend of fluctuation. During the sampling period ranging from March, 2008 to February, 2010 among the adult pterygotes Isopterans was maximum in August and September (monsoon months), minimum in May and more or less constant in December and January (winter months). Same was the case with Hymenoptera. They exhibited a gradual increase from June and attained a peak in August and September followed by gradual decline. The larval forms of Scarabaeidae and Elateridae and those of Diptera especially the Tipulidae were maximum in the monsoon months and minimum in summer and winter. The Scarabaeidae were not collected in months of April to June, and Elaterides were also not encountered from the soil samples of April and May for the total sampling period. The Apterygote population was rich in the epigeal layer. Among the collembolans Poduridae, Isotomidae, Sminthuridae, Entomobryoidae and Jaypygidae were collected. Their number was maximum in the months of January to April and minimum in August to December.

Among the four representatives of collembolans, Poduridae seemed to be dominant as it was obtained in relatively large numbers in the both years of study. The order Diplura was represented by Japyx sp., their number increased during wet months (July – October) coinciding with the peak of abundance of Collembola.

The Mite population of this site exhibited a gradual increase from July and attained a peak in December followed by gradual decline similar trends in population. Maximum numbers of mites were collected in the month of December to February for the both consecutive years. Among the three sub-orders collected Prostigmata was dominant. Cryptostigmata was collected in lesser number. Mesostigmata was collected in moderate numbers. They all showed a minima (April - June) with the increase in depth the number of insects and mites collected was less. The pterygote population consisted of Isopterans with a good amount, the larval forms of Scarabaeidae, Elateridae (Coleoptera) and Tipulidae (Diptera) were also collected which attained a peak in July to October and gradual decline towards the months of March to June.

The collembolans were Poduridae, Isotomidae, Entomobryoidae, at this site though the collembolans exhibited more or more similar trend of fluctuation, Poduridae was the dominant species with maximum collection in February, 2009. Isotomidae and Entomobryoidae exhibited an irregular trend throughout the sampling period. Jaypygidae only Dipluran obtained from this site showed an irregular trend of fluctuation throughout the sampling period.

The Mite population was also collected in good number. Prostigmata was dominant among Cryptostigmata, Mesostigmata. They all exhibited an irregular trend of fluctuation through out the period of investigation.

SITE – WHEAT FIELD

Mineral Soil Population : (0-5 cm depth)

INSECTA – The insects sampled from the soil of this site belong to both the sub-classes. The pterygote population was represented both by adult and larval forms. In comparison to other insects, dipterans were numerous. The orders Coleoptera and Diptera were represented by their larval forms belonging to family – Scarabaeidae, Elateridae and Tipulidae. The apterygote insects were dominated by the collembolans which belong to family – Poduridae, Entomobryoidae and Onychiuridae. The members of Onychiuridae were dominated in numbers. The order Diplura was represented by Japyx sp. The result obtained is recorded in Table 13a, 13c, 14a, 14c and in Figure 14c, 14e, 18c, 18e.

ACARINA – The mite population of this site belonged to Prostigmata, Mesostigmata and Cryptostigmata While considering the relative number mites present at this site Cryptostigmata seemed to be the dominant one. The result obtained is recorded in Table 13e, 14e and in Figure 14g, 18g.

5-10 cm depth

INSECTA – The insectan population of deeper layer was rich in pterygote adult but the pterygotan larval forms were very few and represented by dipterans, isopterans and coleopterans. The Scarabaeidae, Elateridae, Tipulidae and larvae were collected for the two consecutive years. The dipterans were dominated in numbers. The deeper layer apterygotes were Collembola and Diplura. The collembolans were represented by members of family Poduridae, Entomobryoidae, and Onychiuridae. Diplura was of family Japygidae. The result obtained is recorded in Table 13b, 13d, 14b, 14d and in Figure 14d, 14f, 18d, 18f.

ACARINA – The Mite population decreased with the increase in depth. The total acarii were represented by sub-order Cryptostigmata, Prostigmata and Mesostigmata. The result obtained is recorded in Table 13f, 14f and in Figure14h, 18h.

SEASONAL FLUCTUATION

This area is under frequent agriculture operation. The tillage and manuring of the soil disturbed the profile very frequently. As a result the Insects and Mites collected from this site showed an irregular trend of fluctuation. During the sampling period ranging from March 2008 to February 2010 among the adult pterygotes Isopterans was maximum in July and August, minimum in December to March. Same was the case with Hymenoptera. They exhibited a gradual increase from May and attained a peak in July and August followed by gradual decline. The larval forms of Scarabaeidae and Elateridae and those of Diptera especially the Tipulidae were maximum in the monsoon months and minimum in summer and winter. Among the collembolan population Poduridae and Sminthuridae increased suddenly from May to June. Among the acarine population the members from three families, through collected in a large number showed a similar pattern of fluctuation. In the upper layer of soil, the pterygote fauna extracted. Maximum number of the family

Sminthuridae was collected in July, 2009. Family Jaypygidae showed an irregular trend of fluctuation with maximum in July in both the years of the sampling period.

The acarina population too showed an irregular trend in fluctuation. The sub-order of Prostigmata was collected in maximum number and was the dominant, next was Mesostigmata in order of dominance. The mites showed a decline from December to March and then a gradual rise in with a peak in July followed by a gradual decline in post monsoon months.

The soil organisms collected from the deeper layer also through exhibited the same trend of fluctuation as in the epigeal layer, were collected in lesser number.

Figure : Soil Insects and Acari

Table 1a: Climatological Data of Aligarh during 2008-09

Months/Edaphic Factors	Temperature (°C)			Relative Humidity (%)			Dew Point			Total Rainfall (mm)	Total Rainy Days
	Minimum	Maximum	Average	Morning	Evening	Average	Morning	Evening	Average		
March 08	16.37	32.27	24.32	70.23	59.77	65	15.71	22.94	19.325	0.6	1
April 08	25.18	36.95	31.065	54.97	51.97	53.47	17.29	24.63	20.96	24	3
May 08	29.92	37.44	33.68	36.32	51.65	43.985	20.73	24.59	22.66	117.8	9
June 08	25.7	34.08	29.89	82.17	68.77	75.47	25.33	26.92	26.125	184.8	18
July 08	26.23	33.48	29.855	86.10	74.90	80.5	26.30	27.61	26.955	317	15
August 08	25.68	32.90	29.29	87.45	76.87	82.16	26.09	27.32	26.705	240	16
September 08	24.43	33.75	29.09	81.43	64.53	72.98	24.16	25.37	24.765	112.6	7
October 08	20.97	34	27.485	74.42	39.23	56.825	19.55	17.47	18.51	-	-
November 08	13.93	28.82	21.375	80.27	40.13	60.2	13.67	13.07	13.37	6.6	1
December 08	10.90	23.97	17.435	85.35	49.42	67.385	10.74	12.01	11.375	-	-
January 09	9.39	21.65	15.52	89.39	56.32	72.855	10.21	11.85	11.03	-	-
February 09	11.45	26.09	18.77	82.68	41.79	62.235	11.16	11.27	11.215	3.2	1

Table 1b: Climatological Data of Aligarh during 2009-10

Months/Edaphic Factors	Temperature (°C)			Relative Humidity (%)			Dew Point			Total Rainfall (mm)	Total Rainy Days
	Minimum	Maximum	Average	Morning	Evening	Average	Morning	Evening	Average		
March 09	18.39	31.87	25.13	40.40	31.60	36	13.76	12.99	13.37	3.6	2
April 09	20.87	37.98	29.43	40.03	22.23	31.13	12.49	9.98	11.24	12	1
May 09	25.26	39.40	32.33	51.29	31.26	41.27	18.84	18.09	18.46	66.2	8
June 09	27.62	41.47	34.54	46.03	26.9	36.47	19.85	17.6	18.73	15.2	1
July 09	27.44	36.76	32.10	73.77	54.07	63.92	25.39	24.40	24.89	124	9
August 09	26.87	34.79	30.83	79.16	64.97	72.07	25.17	25.85	25.51	320.8	14
September 09	25.45	33.88	29.67	85.13	61.67	73.4	25.24	23.8	24.52	86.2	9
October 09	19.44	32.40	25.92	69.19	44.48	56.84	16.93	16.03	16.48	39.6	2
November 09	14.45	26.93	20.69	75.53	62.23	68.88	12.88	15.39	14.13	41.2	4
December 09	9.77	23.15	16.46	78.71	61.23	69.97	9.31	11.07	10.19	9.4	1
January 10	8.31	17.5	12.90	93.55	80.87	87.21	8.83	11.99	10.41	2.6	1
February 10	12.21	25.34	18.78	81.32	62.04	71.68	11.93	14.76	13.35	16	2

Table 2: Mechanical analysis of soil

Sampling Sites	Soil texture		
	% of sand	% of silt	% of clay
Mango Orchards	44.3	39.0	16.7
Teak Plantation	46.8	38.0	15.2
Unarable Land	43.6	38.0	18.4
Wheat Field	66.7	22.0	11.3

Table 3a: Seasonal Variation in Edaphic Factors at the site Mango Orchards during 2008-09

Months/Edaphic Factors	Temperature (ºC)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
March 08	30	1.36	72	8.4	0.59	1.01	234	7.52	392
April 08	30	1.96	62	8.5	0.59	1.01	234	5.32	616
May 08	30	1.83	66	8.6	0.74	1.27	276	4.24	500
June 08	30	1.01	89	8.5	0.54	0.93	216	4.24	560
July 08	30	2.11	84	8.7	0.48	0.83	216	4.19	616
August 08	29	1.32	92	8.5	0.57	0.98	228	4.35	560
September 08	26	2.77	66	8.4	0.95	1.63	331	4.03	504
October 08	26	1.82	52	8.7	0.65	1.11	242	4.62	448
November 08	23	3.52	52	8.6	0.56	0.96	222	5.32	336
December 08	17	2.25	60	8.5	0.5	0.85	223	4.99	224
January 09	20	3.42	60	8.6	0.54	0.93	216	9.83	224
February 09	17	2.04	52	8.8	0.57	0.98	228	9.56	224

Table 3b: Seasonal Variation in Edaphic Factors at the site Mango Orchards during 2009-10

Months/Edaphic Factors	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
March 09	25	1.11	60	8.9	0.63	1.09	236	9.62	224
April 09	30	0.5	58	9	0.63	1.09	236	8.54	168
May 09	30	1.34	80	8.9	0.68	1.16	253	7.74	224
June 09	41	0.7	61	8.8	0.47	0.8	209	6.61	168
July 09	31	2.15	93	8.9	0.89	1.53	309	12.57	504
August 09	34.5	2.25	81	9	1.16	1.99	375	13.49	392
September 09	30	1.83	73	9	1.11	1.91	361	13.38	500
October 09	25	1.32	38	9.1	0.89	1.53	310	12.41	504
November 09	19	2.82	83	8.8	0.86	1.47	299	16.77	448
December 09	16	3.2	76	9.1	0.63	1.09	236	7.31	504
January 10	18	2.88	52	8.9	0.65	1.11	241	8.65	616
February 10	23	2.35	74	9	0.65	1.11	240	8.42	508

Table 4a: Seasonal Variation in Edaphic Factors at the site Teak Plantation during 2008-09

Months/Edaphic Factors	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
March 08	30	1.32	47	8.2	0.83	1.42	289	4.19	448
April 08	30.5	1.42	62	8.8	0.65	1.11	242	4.4	504
May 08	29	1.32	47	9.2	0.38	0.65	178	3.01	392
June 08	30	2.25	70	9.4	0.42	0.72	189	3.54	392
July 08	29	3.31	81	9.3	0.41	0.7	182	4.19	392
August 08	29	2.25	84	8.9	0.71	1.23	264	3.87	448
September 08	34	1.22	63	9.2	0.5	0.85	223	5.96	336
October 08	28	3.5	59	9.3	0.42	0.72	189	5.85	504
November 08	24	3.73	45	9.4	0.39	0.67	185	6.34	504
December 08	20	3.84	73	9.3	0.2	0.34	93	6.23	448
January 09	15	4.28	65	9	0.38	0.65	178	7.09	392
February 09	18	4.28	77	9.1	0.39	0.67	185	7.9	448

Table 4b: Seasonal Variation in Edaphic Factors at the site Teak Plantation during 2009-10

Months/Edaphic Factors	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
March 09	22	3.63	62	9	0.09	0.16	43	10.37	504
April 09	22	2.35	51	9.2	0.74	1.27	276	12.57	392
May 09	30	1.32	40	9.5	0.3	0.52	142	8.11	392
June 09	31.5	1.11	38	9.5	0.48	0.83	216	7.79	392
July 09	30.5	1.63	84	9.5	0.54	0.93	216	10.16	448
August 09	31	2.35	92	9.6	0.38	0.65	178	8.44	448
September 09	28	3.09	95	9.6	0.36	0.62	171	8.11	392
October 09	27.5	0.91	57	9.5	0.38	0.65	178	7.41	392
November 09	24	3.31	51	9.3	0.45	0.78	203	13.44	448
December 09	20.5	2.56	73	9.4	0.45	0.78	203	9.73	392
January 10	15	2.48	88	9.3	0.45	0.78	203	8.33	504
February 10	19	3.2	88	9.3	0.54	0.93	216	7.84	504

Table 5a: Seasonal Variation in Edaphic Factors at the site Unarable Land during 2008-09

Months/Edaphic Factors	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
March 08	29.5	1.26	62	9.4	0.76	1.27	276	11.02	616
April 08	30	1.86	70	9.5	0.83	1.42	289	10.53	392
May 08	30	1.22	38	9.5	0.75	1.29	281	12.04	728
June 08	30	1.83	92	9.7	0.77	1.32	287	10.53	336
July 08	33.5	4.28	76	9.8	0.54	0.93	216	8.97	392
August 08	31.5	2.46	91	9.5	0.6	1.03	225	11.82	504
September 08	33	2.88	69	9.4	0.44	0.75	196	9.94	336
October 08	30	3.09	54	9.4	0.62	1.06	231	7.09	392
November 08	21	1.52	54	9.4	0.72	1.24	270	10.64	504
December 08	18	2.25	52	9.2	0.72	1.24	270	7.79	448
January 09	18.5	4.17	60	9.2	0.65	1.11	223	11.02	504
February 09	23	3.63	46	9.1	0.69	1.19	259	11.02	504

Table 5b: Seasonal Variation in Edaphic Factors at the site Unarable Land during 2009-10

Months/Edaphic Factors	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
March 09	32	3.09	41	9.3	0.69	1.19	259	10.16	560
April 09	33	0.91	31	9.7	0.77	1.32	287	6.5	560
May 09	34	1.63	78	9.8	0.81	1.4	284	7.25	392
June 09	33	0.3	32	9.6	0.66	1.14	248	7.74	392
July 09	35	1.32	86	9.6	0.74	1.27	276	9.73	560
August 09	35	2.46	66	9.8	0.74	1.27	276	5.85	728
September 09	30	1.73	64	9.9	0.72	1.24	270	10.53	616
October 09	33	1.84	34	9.9	0.71	1.22	264	11.18	504
November 09	27	2.56	81	9.4	0.71	1.22	264	12.2	504
December 09	19	3.31	70	9.5	0.66	1.14	248	9.35	616
January 10	19	3.84	69	9.7	0.66	1.14	248	9.62	560
February 10	21	3.62	69	9.7	0.77	1.32	287	10.75	560

Table 6a: Seasonal Variation in Edaphic Factors at the site Wheat Field during 2008-09

Months/Edaphic Factors	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
April 08	29	1.83	68	9.4	0.29	0.49	121	11.04	442
May 08	30	1.22	36	9.5	0.23	0.39	107	9.12	504
June 08	32	1.86	70	9.4	0.26	0.44	132	11.02	392
July 08	31	3.22	76	9.6	0.54	0.93	153	9.94	448
August 08	31	2.88	91	9.8	0.62	1.06	181	11.82	504
September 08	29	3.09	69	9.7	0.65	1.11	172	11.02	392
October 08	28	2.46	54	9.4	0.72	1.24	185	10.64	504
November 08	20	2.25	60	9.2	0.62	1.06	175	11.02	448
December 08	17.5	1.73	82	9	0.39	0.67	185	11.45	504
January 09	24	1.83	63	9.1	0.56	0.44	121	9.51	392
February 09	23	1.01	84	9.1	0.29	0.49	135	11.02	448
March 09	25	0.6	38	9	0.24	0.41	114	14.04	392

Table 6b: Seasonal Variation in Edaphic Factors at the site Wheat Field during 2009-10

Months/Edaphic Factors	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Organic Matter (%)	Available Nitrogen (ppm)	Phosphate (ppm)	Potassium (ppm)
April 09	33	1.69	66	9.7	0.66	1.14	178	7.25	392
May 09	35	0.91	32	9.3	0.39	0.67	160	6.5	560
June 09	34	1.33	78	9.8	0.26	0.44	135	10.53	392
July 09	32	1.73	64	9.8	0.29	0.49	142	9.86	448
August 09	31	2.46	66	9.7	0.71	1.22	185	11.18	392
September 09	29	2.56	70	9.5	0.66	1.14	180	9.35	392
October 09	24	3.84	69	9.4	0.39	0.67	142	12.2	560
November 09	19	1.52	68	8.9	0.26	0.44	121	9.62	448
December 09	19	1.11	78	9	0.24	0.41	114	6.88	448
January 10	26	0.7	76	9.2	0.23	0.39	107	9.13	448
February 10	24	0.4	80	9.1	0.26	0.44	121	9.89	448
March 10	33	3.09	41	9.6	0.69	1.19	170	10.16	560

Table 7a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Mango Orchards during 2008-09.

Order/Form \ Month		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	4	5	14	4	20	15	1	1	4	45	0	4
	Larvae	-	1	-	2	-	-	-	-	-	-	-	-
Coleoptera	Adult	3	5	6	2	2	1	2	-	5	1	-	3
	Larvae	-	2	-	-	2	-	-	-	-	-	-	-
Hymenoptera	Adult	2	2	-	5	20	2	-	-	-	6	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	3	2	1	-	2	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	6	4	7	10	12	10	8	7	7	6	5	6
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	2	3	-	-	-	-	-	-	-	-	-	3

Table 7b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Mango Orchards during 2008-09.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	18	12	10	4	5	9	2	2	3	2	-	6
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	4	2	2	-	3	2	2	-	1	-	1	1
	Larvae	2	-	-	-	-	-	1	-	-	-	-	-
Hymenoptera	Adult	2	-	-	-	2	4	3	-	-	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	1	1	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	4	6	7	7	8	6	4	3	2	3	3	2
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-

Table 7c: Mean Value of Pterygote Insectan Population of Litter of an area of 250Sq.cm. at the Site of Mango Orchards during 2008-09.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	5	4	8	5	4	5	5	1	1	-	1	9
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	3	2	2	2	-	2	2	-	1	-	-	2
	Larvae	12	-	10	-	-	-	-	-	-	-	-	-
Hymenoptera	Adult	2	-	2	-	-	-	-	-	-	-	1	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	5	2	-	-	-	1	-	1	-	-	-	1
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	-	-	-	-	-	-	-	-	3	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-

Table 7d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Mango Orchards during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	107	10	5	-	15	3	-	-	1	15	12	104
	Isotomidae	-	2	-	-	-	-	-	-	-	-	-	-
	Sminthuridae	2	-	-	1	-	-	-	-	-	-	-	-
	Entomobryoidae	18	-	5	-	-	1	4	3	1	14	37	4
	Onychiuridae	7	-	5	-	-	-	-	2	-	-	1	3
Diplura	Jaypygidae	1	-	-	1	-	1	2	-	-	-	-	-

Table 7e: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Mango Orchards during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	35	9	2	1	2	1	3	-	3	-	2	71
	Isotomidae	-	1	-	-	-	-	-	-	-	-	-	-
	Sminthuridae	-	-	-	-	-	-	-	-	-	-	-	-
	Entomobryoidae	4	1	1	-	-	2	-	-	-	-	7	4
	Onychiuridae	2	-	-	-	-	-	1	-	1	-	1	4
Diplura	Jaypygidae	1	-	1	2	-	2	-	-	-	-	-	-

Table 7f: Mean Value of Apterygote Insectan Population of Litter of an area of 250 Sq. cm. at the Site of Mango Orchards during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	4	2	1	-	12	1	-	-	1	1	5	1
	Isotomidae	-	-	-	-	-	-	-	-	-	-	-	-
	Sminthuridae	-	-	-	-	-	1	-	-	-	-	-	-
	Entomobryoidae	-	-	-	-	4	-	-	-	-	-	-	1
	Onychiuridae	-	-	1	-	-	-	-	-	1	-	-	-
Diplura	Jaypygidae	-	1	-	-	3	1	1	-	-	-	-	-

Table 7g: Mean Value of Mite Population of Mineral Soil Up to a depth of 0- 5 cm. at the Site of Mango Orchards during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	3	1	1	-	-	1	-	-	4	-	2	-
	Prostigmata	8	12	32	4	24	22	20	15	21	2	14	8
	Mesostigmata	5	2	10	1	2	7	4	-	-	-	1	12

Table 7h: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Mango Orchards during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	-	-	-	1	-	-	-	-	-	-	-	1
	Prostigmata	8	4	12	0	20	30	22	3	-	1	5	21
	Mesostigmata	1	-	2	-	1	2	8	1	-	1	1	19

Table 7i: Mean Value of Mite Population of Litter of an area of 250 Sq. cm. at the Site of Mango Orchards during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	-	-	-	1	1	-	1	-	-	-	-	15
	Prostigmata	2	1	18	-	25	26	12	-	-	4	1	14
	Mesostigmata	1	-	2	2	-	4	5	-	1	2	4	27

Table 8a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm at the Site of Mango Orchards during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	5	12	34	6	22	24	33	10	5	1	2	10
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	3	5	7	1	5	3	7	1	1	-	1	-
	Larvae	8	4	2	-	1	1	1	5	1	-	-	16
Hymenoptera	Adult	1	1	1	1	2	-	-	1	-	2	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	8	-	-	-	-	-	-	-	1	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	6	7	5	16	18	16	14	12	11	8	6	4
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	2	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	5	-	-	-	-	-	-	-	-	-	-	-

Table 8b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Mango Orchards during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	34	23	52	25	23	40	40	14	4	-	3	15
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	6	1	4	2	7	8	3	1	-	1	1	1
	Larvae	24	1	17	-	-	8	1	-	5	-	-	10
Hymenoptera	Adult	2	1	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	2	-	-	-	-	-	-	-	8	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	3	4	4	6	8	11	10	8	6	4	3	2
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-

Table 8c: Mean Value of Pterygote Insectan Population of Litter of an area of 250Sq.cm. at the Site of Mango Orchards during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	7	10	5	8	2	5	10	11	2	-	3	1
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	3	-	1	3	-	2	-	1	-	-	1	1
	Larvae	10	4	-	-	1	-	-	10	-	-	-	14
Hymenoptera	Adult	1	1	1	1	1	1	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	16	-	1	-	-	-	-	-	2	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	-	-	-	-	-	-	-	1	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-

Table 8d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Mango Orchards during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	291	-	2	-	21	4	-	-	6	360	426	109
	Isotomidae	-	-	-	-	-	-	-	-	-	-	-	-
	Sminthuridae	1	-	1	-	-	2	1	-	-	-	-	-
	Entomobryoidae	13	1	-	-	-	-	1	2	13	-	11	2
	Onychiuridae	12	1	1	-	-	-	-	-	2	12	34	66
Diplura	Jaypygidae	-	-	1	-	2	4	6	2	1	-	-	1

Table 8e: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Mango Orchards during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	55	2	-	-	2	1	-	1	35	95	93	88
	Isotomidae	-	-	-	-	-	-	-	-	-	-	-	1
	Sminthuridae	-	-	-	-	-	2	-	-	-	-	1	-
	Entomobryoidae	3	2	2	-	-	-	-	-	3	-	1	1
	Onychiuridae	3	-	-	-	-	-	-	-	3	12	7	95
Diplura	Jaypygidae		-	-	-	1	3	-	1	2	-	2	-

Table 8f: Mean Value of Apterygote Insectan Population of Litter of an area of 250 Sq. cm. at the Site of Mango Orchards during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	2	-	-	2	25	1	1	-	4	205	1	1
	Isotomidae	-	-	-	-	-	-	-	-	-	-	-	-
	Sminthuridae	-	-	-	1	2	1	-	-	-	-	-	-
	Entomobryoidae	-	-	2	-	5	-	-	-	2	4	-	-
	Onychiuridae	-	-	-	-	6	-	-	-	-	20	-	-
Diplura	Jaypygidae	-	-	-	-	-	2	1	1	-	-	-	-

Table 8g: Mean Value of Mite Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Mango Orchards during 2009-10.

Order/Suborder \ Month		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	5	1	-	-	-	-	-	1	-	2	1	-
	Prostigmata	11	16	52	1	31	29	28	15	79	50	22	9
	Mesostigmata	18	4	15	-	1	10	6	1	18	13	-	-

Table 8h: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Mango Orchards during 2009-10.

Order/Suborder \ Month		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	1	-	1	-	-	-	-	-	1	-	1	-
	Prostigmata	10	5	21	-	23	41	32	10	57	22	21	13
	Mesostigmata	2	3	8	-	2	6	13	4	19	5	2	-

Table 8i: Mean Value of Mite Population of Litter of an area of 250 Sq. cm. at the Site of Mango Orchards during 2009-10.

Order/Suborder \ Month		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	-	-	-	-	-	-	1	3	-	1	2	-
	Prostigmata	5	-	76	1	258	362	122	15	27	52	2	-
	Mesostigmata	-	-	9	1	37	25	53	9	14	9	2	-

Table 9a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Teak Plantation during 2008-09.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	10	15	10	10	23	20	2	2	-	2	-	1
	Larvae	-	-	-	-	-	2	-	-	-	-	-	-
Coleoptera	Adult	5	13	2	1	3	6	1	4		1	-	1
	Larvae	-	4	5	-	-	18	2	-	-	-	1	1
Hymenoptera	Adult	-	1	2	3	22	2	20	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	2	-	1	1	-	-	-	-	-	-	-	1
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	3	2	2	11	14	12	12	10	8	4	1	2
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	10	5	-	-	3	4	4	4	-	-	26

Table 9b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Teak Plantation during 2008-09.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	12	12	21	12	20	30	24	24	17	2	1	4
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	3	2	2		8	5	5	2	4			
	Larvae	-	2	-	2	-	1	1	-	-	-	-	-
Hymenoptera	Adult	1	-	4	-	3	5	20	30	-	-	-	1
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	2	1	-	1	-	-	1	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	1	1	2	5	4	3	2	2	1	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	15	2	-	4	-	1	10	16	5	-	-	-

Table 9c: Mean Value of Pterygote Insectan Population of Litter of an area of 250Sq.cm. at the Site of Teak Plantation during 2008-09.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	7	9	16	4	2	3	12	7	2	3	-	3
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	2	2	-	1	1	-	5	2	-	1	-	1
	Larvae	9	-	25	-	-	-	2	-	-	-	-	-
Hymenoptera	Adult	1	1	-	5	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	3	8	1	-	2	-	-	-	-	-	-	1
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	-	2	1	-	-	-	-	-	-	-	-	2
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	2	-	10	-	-	-	-	-	-	-

Table 9d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Teak Plantation during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	98	60	1	1	-	2	1	-	3	44	5	25
	Isotomidae	13	4	-	4	-	2	-	-	3	14	-	7
	Sminthuridae	4	2	2	3	-	-	-	-	1	4	13	8
	Entomobryoidae	11	10	-	1	2	1	-	1	-	1	1	2
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	2	1	1	-	1	1	-	-	5	-	1	1

Table 9e: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Teak Plantation during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	18	11	2	1	1	1	-	-	1	-	1	1
	Isotomidae	2	1	-	1	-	-	1	1	-	-	-	1
	Sminthuridae	-	-	-	1	-	-	-	-	-	-	3	-
	Entomobryoidae	2	1	1	-	-	1	-	1	-	-	-	-
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	2	2	1	-	-	1	-	1	1	1	1	-

Table 9f: Mean Value of Apterygote Insectan Population of Litter of an area of 250 Sq. cm. at the Site of Teak Plantation during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	10	2	1	1	2	2	1	-	-	1	-	6
	Isotomidae	-	1	-	-	-	-	1	-	-	2	-	-
	Sminthuridae	2	4	2	-	-	-	-	-	-	-	-	-
	Entomobryoidae	1	5	-	-	-	-	-	-	-	-	-	-
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	2	-	-	1	-	-	1	-	-	-	-	-

Table 9g: Mean Value of Mite Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Teak Plantation during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	1	-	1	-	-	1	-	-	-	-	-	4
	Prostigmata	11	12	3	5	25	18	5	10	8	13	5	21
	Mesostigmata	2	3	1	1	10	2	7	6	6	3	1	1

Table 9h: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Teak Plantation during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	3	-	-	1	2	-	-	-	-	-	-	1
	Prostigmata	6	12	1	10	20	15	4	8	4	5	9	4
	Mesostigmata	4	1	1	1	1	-	1	3	-	2	3	3

Table 9i: Mean Value of Mite Population of Litter of an area of 250 Sq. cm. at the Site of Teak Plantation during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	2	-	-	2	3	1	-	-	7	1	-	1
	Prostigmata	1	4	3	1	55	52	1	2	1	5	1	-
	Mesostigmata	2	2	1	1	15	4	-	-	1	-	2	2

Table 10a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Teak Plantation during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	16	19	13	13	8	59	40	30	6	-	1	3
	Larvae	-	-	10	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	4	17	3	-	1	21	-	1	-	-	-	1
	Larvae	1	1	-	-	1	-	6	5	-	-	-	-
Hymenoptera	Adult	-	1	7	58	20	5	75	62	-	29	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	3	2	8	1	1	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	5	6	6	14	16	14	8	7	6	4	2	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	1	-	-	1	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	7	-	-	-	-	-	-	-	-	-	-

Table 10b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Teak Plantation during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	14	11	15	13	13	23	29	29	23	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	1	4	2	3	3	-	2	1	-	-	-	-
	Larvae	1	-	-	-	-	-	-	3	5	-	-	-
Hymenoptera	Adult	-	-	-	13	4	54	39	51	-	15	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	2	2	2	-	-	-	-	3	-	-	1	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	4	6	8	10	12	8	6	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	2	-	-	-	-	-	-	-	-	8	-	-

Table 10c: Mean Value of Pterygote Insectan Population of Litter of an area of 250Sq.cm. at the Site of Teak Plantation during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	4	13	6	8	6	6	10	7	2	-	1	3
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	2	4	-	-	-	-	-	-	-	-	-	-
	Larvae	4	35	40	4	-	-	-	1	-	-	-	-
Hymenoptera	Adult	1	-	6	-	-	14	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	8	7	1	-	1	-	-	-	-	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	-	1	1	3	1	-	-	1	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	1	10	-	-	-	-	-	-	-	-	-	-

Table 10d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Teak Plantation during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	277	145	-	2	-	1	1	-	31	4	4	19
	Isotomidae	19	6	1	7	-	4	-	-	2	2	3	16
	Sminthuridae	5	1	-	1	-	1	-	-	3	1	1	10
	Entomobryoidae	16	16	2	-	1	1	-	-	5	1	6	2
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	2	2	-	1	1	-	2	-	5	2	-	-

Table 10e: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Teak Plantation during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	27	29	1	1	1	1	-	2	6	-	8	-
	Isotomidae	4	4	-	3	-	1	-	-	2	3	2	1
	Sminthuridae	-	-	-	1	-	-	-	-	-	1	2	2
	Entomobryoidae	4	3	-	-	-	2	-	-	-	2	2	-
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	2	2	-	1	-	1	1	3	-	-	-	-

Table 10f: Mean Value of Apterygote Insectan Population of Litter of an area of 250 Sq. cm. at the Site of Teak Plantation during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	11	1	1	-	3	1	1	-	-	-	13	2
	Isotomidae	-	-	-	-	-	-	-	1	1	-	2	-
	Sminthuridae	-	-	-	-	-	-	-	-	-	-	5	2
	Entomobryoidae	5	24	-	1	2	-	-	-	-	-	2	-
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	2	1	-	-	-	-	-	-	-	-	-	-

Table 10g: Mean Value of Mite Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Teak Plantation during 2009-10.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	-	1	7	1	2	2	-	1	1	-	-	2
	Prostigmata	32	32	12	38	161	42	3	64	43	64	7	8
	Mesostigmata	15	8	7	4	25	5	-	2	8	4	1	5

Table 10h: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Teak Plantation during 2009-10.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	6	-	1	1	1	-	-	-	-	-	-	2
	Prostigmata	15	26	2	17	59	48	22	14	24	15	-	5
	Mesostigmata	8	3	-	3	7	-	1	1	3	6	2	2

Table 10i: Mean Value of Mite Population of Litter of an area of 250 Sq. cm. at the Site of Teak Plantation during 2009-10.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	4	1	-	1	-	-	-	-	2	-	-	1
	Prostigmata	7	-	4	1	149	131	107	77	111	31	34	20
	Mesostigmata	3	7	1	-	47	12	48	10	5	2	3	4

Table 11a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Unarable Land during 2008-09.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	12	10	4	9	21	17	12	7	4	-	1	3
	Larvae	-	-	-	-	14	10	10	29	3	3	7	41
Coleoptera	Adult	2	5	2	1	5	-	-	3	-	-	-	1
	Larvae	2	-	2	1	2	4	1	7	-	-	6	-
Hymenoptera	Adult	-	4	17	6	40	38	20	17	19	11	7	6
	Larvae	-	-	1	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	2	2	1	-	-	1	-	-	-	1	-	1
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	15	9	10	30	45	45	40	30	20	18	10	8
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	1	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	5	-	-	5	8	8	12	156	-	6	-	10

Table 11b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Unarable Land during 2008-09.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	6	5	2	2	20	17	3	3	1	4	-	6
	Larvae	-	-	-	-	10	-	11	11	-	2	-	-
Coleoptera	Adult	1	1	2	1	8	-	-	1	-	-	11	-
	Larvae	-	-	-	2	-	-	2	1	-	1	-	2
Hymenoptera	Adult	5	3	2	1	-	3	-	-	6	4	5	4
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	-	-	2	-	-	-	-	-	-	1	-	1
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	8	10	16	20	25	20	18	16	10	10	9	8
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	1	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	5	3	-	7	7	22	-	-	24	8

Table 11c: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Unarable Land during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	88	25	1	1	2	1	1	2	-	-	114	519
	Isotomidae	22	8	-	1	2	-	6	-	1	6	21	172
	Sminthuridae	1	-	-	1	-	-	-	-	-	1	3	-
	Entomobryoidae	12	2	1	1	2	2	-	1	3	1	16	45
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	2	2	1	1	-	-	-	5	21	-	1	1

Table 11d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Unarable Land during 2008-09.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	8	3	1	1	1	-	-	2	-	-	9	94
	Isotomidae	-	1	1	-	-	-	1	-	-	1	1	23
	Sminthuridae	-	-	-	-	-	-	-	-	-	-	-	-
	Entomobryoidae	1	-	1	2	-	1	1	-	2	2	-	13
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	-	-	1	-	1	1	-	1	-	-	2	2

Table 11e: Mean Value of Mite Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Unarable Land during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	1	2	-	-	12	10	-	-	1	-	-	16
	Prostigmata	12	20	10	9	18	12	20	58	26	13	28	12
	Mesostigmata	4	1	2	21	11	4	22	37	42	27	33	1

Table 11f: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Unarable Land during 2008-09.

Order/Suborder	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	1	-	1	-	4	2	-	-	-	-	-	7
	Prostigmata	7	5	2	2	9	3	3	5	1	-	4	9
	Mesostigmata	-	1	1	-	1	4	21	-	-	-	10	-

Table 12a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Unarable Land during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	17	12	11	29	30	26	48	33	11	2	6	1
	Larvae	-	-	-	-	4	-	2	3	-	-	-	-
Coleoptera	Adult	3	15	-	-	3	3	1	8	1	1	-	1
	Larvae	36	13	1	5	5	1	13	73	97	3	4	6
Hymenoptera	Adult	-	1	10	1	67	19	8	11	12	26	1	11
	Larvae	-	1	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	1	-	-	2	2	3	-	1	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	18	16	15	20	25	35	35	32	28	22	24	21
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	17	15	47	13	8	34	1	11	-	-

Table 12b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Unarable Land during 2009-10.

Order/Form	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Diptera	Adult	8	47	21	38	44	60	60	12	8	1	3	6
	Larvae	9	-	-	-	-	-	-	-	-	-	-	-
Coleoptera	Adult	-	32	-	-	10	12	5	-	4	2	1	1
	Larvae	3	74	-	4	5	3	4	7	12	4	1	2
Hymenoptera	Adult	7	2	19	-	11	3	76	1	4	20	7	6
	Larvae	-	1	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	-	1	-	-	3	-	1	-	2	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	20	24	30	35	36	42	38	34	20	18	19	20
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	10	22	24	7	15	22	2	-	6	8

Table 12c: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Unarable Land during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	293	34	2	1	3	-	-	11	2	2	9	180
	Isotomidae	66	-	-	2	2	-	1	3	8	12	-	3
	Sminthuridae	-	-	-	1	1	-	-	-	3	11	22	13
	Entomobryoidae	18	1	-	1	2	1	3	4	4	12	-	12
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	1	5	1	-	1	1	1	-	-	3	30	9

Table 12d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Unarable Land during 2009-10.

Order/Family	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Collembola	Poduridae	27	2	-	1	1	-	-	3	6	-	-	64
	Isotomidae	-	1	-	1	-	-	3	-	12	-	-	5
	Sminthuridae	-	-	-	2	-	-	1	-	1	-	19	6
	Entomobryoidae	1	-	-	-	-	1	1	1	10	1	-	16
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	1	2	2	-	1	1	4	1	1	9	9	2

Table 12e: Mean Value of Mite Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Unarable Land during 2009-10.

Order/Suborder \ Month		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	2	3	-	-	27	28	2	5	4	229	1	23
	Prostigmata	45	24	19	18	36	24	61	46	45	105	57	62
	Mesostigmata	9	3	4	134	24	11	17	16	24	30	19	18

Table 12f: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Unarable Land during 2009-10.

Order/Suborder \ Month		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Acarina	Cryptostigmata	2	-	3	-	5	4	38	1	1	1	2	3
	Prostigmata	12	12	4	1	8	8	45	37	22	22	27	36
	Mesostigmata	10	-	1	68	2	1	7	17	18	17	8	8

Table 13a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Wheat Field during 2008-09.

Order/Form	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Diptera	Adult	9	8	18	22	20	17	13	7	1	-	-	13
	Larvae	-	-	-	6	11	8	10	21	2	3	7	20
Coleoptera	Adult	2	1	12	10	7	5	4	4	5	2	1	3
	Larvae	2	-	2	4	2	4	1	3	-	-	6	-
Hymenoptera	Adult	15	12	22	18	16	10	8	7	-	-	-	17
	Larvae	-	-	1	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	1	-	3	4	-	1	-	1	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	1	-	2	2	-	-	-	-	-	-	-	2
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	7	5	12	14	10	8	7	2	-	1	-	9
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	1	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	4	2	2	5	8	9	11	12	-	6	8	10

Table 13b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Wheat Field during 2008-09.

Order/Form \ Month		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Diptera	Adult	12	10	15	15	12	10	6	4	-	-	3	14
	Larvae	-	1	3	8	10	9	11	10	1	2	1	-
Coleoptera	Adult	2	2	15	17	11	8	2	1	2	-	-	3
	Larvae	4	3	2	2	5	3	2	1	-	1	-	2
Hymenoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	2	4	6	2	1	-	-	-	-	5	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	1	-	5	7	4	2	1	2	1	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	4	3	5	3	2-	7	8	12	1	2	9	6

Table 13c: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Wheat field during 2008-09.

Order/Family	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Collembola	Poduridae	-	1	4	6	3	2	1	-	7	-	-	-
	Isotomidae	-	-	-	-	-	-	-	-	-	-	-	-
	Sminthuridae	-	-	-	-	-	-	-	-	-	-	-	-
	Entomobryoidae	-	-	-	-	-	-	-	-	-	-	-	-
	Onychiuridae	1	2	6	9	5	3	2	-	-	-	1	-
Diplura	Jaypygidae	2	1	2	4	2	1	-	-	-	-	-	3

Table 13d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Wheat Field during 2008-09.

Order/Family	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Collembola	Poduridae	-	2	5	7	4	3	2	1	-	-	2	-
	Isotomidae	-	-	-	-	-	-	-	-	-	-	-	-
	Sminthuridae	2	3	6	9	2	1	-	-	1	-	4	-
	Entomobryoidae	-	-	-	-	-	-	-	-	-	-	-	-
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	-	-	-	-	-	-	-	-	-	-	-	-

Table 13e: Mean Value of Mite Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Wheat Field during 2008-09.

Order/Suborder	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Acarina	Cryptostigmata	1	2	5	7	4	2	1	-	-	-	2	-
	Prostigmata	-	1	14	16	7	3	2	-	-	-	12	1
	Mesostigmata	1	1	7	10	8	4	2	-	-	-	5	-

Table 13f: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Wheat Field during 2008-09.

Order/Suborder	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Acarina	Cryptostigmata	2	4	8	10	7	4	3	2	1	2	-	-
	Prostigmata	1	4	6	8	5	3	2	1	-	-	5	2
	Mesostigmata	1	5	7	11	2	1	-	-	-	-	2	-

Table 14a: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Wheat Field during 2009-10.

Order/Form	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Diptera	Adult	40	35	50	55	38	30	28	12	-	1	19	49
	Larvae	-	-	6	8	14	12	10	29	3	3	7	41
Coleoptera	Adult	8	7	15	16	10	8	6	2	-	-	5	12
	Larvae	5	-	4	1	2	4	1	7	-	-	6	-
Hymenoptera	Adult	1	1	5	8	4	2	1	-	-	-	1	-
	Larvae	-	-	1	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	3
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	1	-	1	2	-	-	-	-	-	1	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	3	1	6	8	3	2	1	-	-	-	-	4
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	3	1	-	4	8	7	11	1	2	6	-	8

Table 14b: Mean Value of Pterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Wheat Field during 2009-10.

Order/Form	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Diptera	Adult	42	39	50	55	38	20	12	8	-	9	26	47
	Larvae	-	-	-	5	10	6	11	11	-	2	-	-
Coleoptera	Adult	15	12	24	35	16	10	7	2	-	-	3	28
	Larvae	6	5	2	2	1	-	2	1	-	1	-	2
Hymenoptera	Adult	-	-	2	5	-	-	-	-	1	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Thysanoptera	Adult	1	3	5	8	4	3	2	-	-	-	-	2
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Homoptera	Adult	-	-	2	3	-	-	-	-	-	1	2	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Isoptera	Adult	6	6	9	12	7	4	3	2	1	-	-	4
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Pscoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	Adult	-	-	-	-	-	-	-	-	-	-	-	-
	Larvae	2	3	4	3	-	8	8	18	-	-	14	9

Table 14c: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Wheat Field during 2009-10.

Order/Family	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Collembola	Poduridae	-	2	14	17	8	5	3	-	-	2	12	1
	Isotomidae	1	1	5	7	3	-	-	-	-	-	1	-
	Sminthuridae	-	3	15	18	12	5	3	2	-	1	11	-
	Entomobryoidae	2	4	7	5	-	2	-	-	2	5	-	-
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	1	1	4	6	3	2	-	-	1	-	-	-

Table 14d: Mean Value of Apterygote Insectan Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Wheat Field during 2009-10.

Order/Family	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Collembola	Poduridae	2	2	21	32	18	7	6	-	-	8	29	3
	Isotomidae	1	1	4	7	3	2	1	-	-	-	3	-
	Sminthuridae	2	4	7	9	3	2	1	-	-	-	8	-
	Entomobryoidae	-	-	-	-	-	-	-	-	1	-	-	-
	Onychiuridae	-	-	-	-	-	-	-	-	-	-	-	-
Diplura	Jaypygidae	1	1	3	5	4	2	1	-	2	-	1	-

Table 14e: Mean Value of Mite Population of Mineral Soil Up to a depth of 0-5 cm. at the Site of Wheat Field during 2009-10.

Order/Suborder	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Acarina	Cryptostigmata	-	-	-	-	-	-	-	-	-	-	-	-
	Prostigmata	2	2	5	7	3	2	1	-	-	1	-	3
	Mesostigmata	-	1	3	5	2	1	-	1	-	1	-	-

Table 14f: Mean Value of Mite Population of Mineral Soil Up to a depth of 5-10 cm. at the Site of Wheat Field during 2009-10.

Order/Suborder	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Acarina	Cryptostigmata	-	-	-	-	-	-	-	-	-	-	-	-
	Prostigmata	5	4	8	10	8	3	2	1	1	-	2	6
	Mesostigmata	1	1	4	6	3	2	2	-	-	-	1	-

Table 15: Relationship between Insectan population and Acarine population at the site of Mango Orchards

	2008-09	Significance	2009-10	Significance
Total Apterygote vs. Total Pterygote				
5cm	-0.1907	ns	-0.6399	*
10cm	0.174659	ns	-0.44302	ns
Litter	-0.0808	ns	-0.38513	ns
Total Apterygote vs. Mites				
5cm	-0.13717	ns	-0.00549	ns
10cm	0.51447	ns	-0.11059	ns
Litter	0.22185	ns	0.01745	ns
Total Pterygote vs. Mites				
5cm	-0.10577	ns	-0.0478	ns
10cm	0.191658	ns	0.090625	ns
Litter	0.160067	ns	-0.35311	ns

Table 16: Relationship between Insectan population and Acarine population at the site of Teak Plantation

	2008-09	Significance	2009-10	Significance
Total Apterygote vs. Total Pterygote				
5cm	-0.24782	ns	-0.29297	ns
10cm	-0.18803	ns	-0.29488	ns
Litter	0.439293	ns	0.348706	ns
Total Apterygote vs. Mites				
5cm	0.00144	ns	-0.09464	ns
10cm	0.185492	ns	0.016317	ns
Litter	-0.17912	ns	-0.3787	ns
Total Pterygote vs. Mites				
5cm	0.482525	ns	-0.00694	ns
10cm	0.095337	ns	0.309201	ns
Litter	-0.31502	ns	-0.37873	ns

Table 17: Relationship between Insectan population and Acarine population at the site of Unarable Land

	2008-09	Significance	2009-10	Significance
Total Apterygote vs. Total Pterygote				
5cm	-0.128	ns	-0.256	ns
10cm	-0.217	ns	-0.408	ns
Total Apterygote vs. Mites				
5cm	-0.142	ns	-0.081	ns
10cm	0.336	ns	0.138	ns
Total Pterygote vs. Mites				
5cm	0.222	ns	-0.180	ns
10cm	0.389	ns	0.036	ns

Table 18: Relationship between Insectan population and Acarine population at the site of Wheat Field

	2008-09	Significance	2009-10	Significance
Total Apterygote vs. Total Pterygote				
5cm	0.678	*	0.480	ns
10cm	0.806	*	0.575	ns
Total Apterygote vs. Mites				
5cm	0.805	*	0.863	*
10cm	0.974	*	0.735	*
Total Pterygote vs. Mites				
5cm	0.601	*	0.677	*
10cm	0.863	*	0.933	*

Table 19a: Relationship between Insectan population and Acarine population with edaphic factors at the site of Mango Orchards during 2008-09

Variables	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.056	0.0169	25.262	NS
Soil moisture	-0.237	-0.0108	2.377	NS
Relative humidity	0.403	0.3346	59.249	NS
pH	-0.019	-0.0001	8.570	NS
Organic carbon	-0.429	-0.0032	0.683	NS
Organic matter	-0.431	-0.0055	1.172	NS
Nitrogen	-0.271	-0.5278	251.456	NS
Phosphate	-0.440	-0.0538	6.972	NS
Potassium	0.184	1.6209	394.901	NS
0–5 cm				
Apterygote				
Soil temperature	-0.277	-0.0320	26.697	NS
Soil moisture	-0.127	-0.0022	2.189	NS
Relative humidity	-0.200	-0.0634	69.296	NS
pH	0.068	0.0002	8.561	NS
Organic carbon	-0.174	-0.0005	0.623	NS
Organic matter	-0.175	-0.0009	1.068	NS
Nitrogen	-0.174	-0.1296	243.013	NS
Phosphate	0.765	0.0358	4.529	**
Potassium	-0.515	-1.7362	489.661	NS
0–5 cm				
Mites				
Soil temperature	0.342	0.1612	22.470	NS
Soil moisture	0.112	0.0080	1.959	NS
Relative humidity	0.086	0.1109	65.050	NS
pH	0.190	0.0021	8.524	NS
Organic carbon	0.397	0.0046	0.515	NS
Organic matter	0.405	0.0081	0.881	NS
Nitrogen	0.401	1.2166	214.704	NS
Phosphate	-0.167	-0.0319	6.317	NS
Potassium	0.294	4.0366	353.607	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
<u>Pterygote</u>				
Soil temperature	0.713	0.4403	19.686	**
Soil moisture	-0.571	-0.0534	2.842	NS
Relative humidity	0.520	0.8814	55.278	NS
pH	-0.438	-0.0064	8.654	NS
Organic carbon	0.060	0.0009	0.594	NS
Organic matter	0.062	0.0016	1.019	NS
Nitrogen	0.098	0.3909	233.523	NS
Phosphate	-0.150	-0.0376	6.194	NS
Potassium	0.536	9.6625	302.417	NS
5–10 cm				
<u>Apterygote</u>				
Soil temperature	-0.348	-0.0767	26.714	NS
Soil moisture	-0.133	-0.0044	2.178	NS
Relative humidity	-0.268	-0.1621	69.465	NS
pH	0.326	0.0017	8.543	NS
Organic carbon	-0.102	-0.0006	0.614	NS
Organic matter	-0.100	-0.0009	1.054	NS
Nitrogen	-0.123	-0.1744	241.217	NS
Phosphate	0.725	0.0647	4.800	**
Potassium	-0.432	-2.7795	471.653	NS
5–10 cm				
<u>Mites</u>				
Soil temperature	-0.096	-0.0354	26.151	NS
Soil moisture	-0.124	-0.0069	2.212	NS
Relative humidity	0.177	0.1801	64.789	NS
pH	0.236	0.0021	8.538	NS
Organic carbon	0.311	0.0028	0.568	NS
Organic matter	0.319	0.0050	0.973	NS
Nitrogen	0.345	0.8230	227.585	NS
Phosphate	0.148	0.0222	5.381	NS
Potassium	0.050	0.5452	426.216	NS

** = significant at 5% only; ** = significant at 5% and 1%; NS = not significant*

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
Litter				
Pterygote				
Soil temperature	0.422	0.2678	23.346	NS
Soil moisture	-0.421	-0.0404	2.468	NS
Relative humidity	0.128	0.2231	65.317	NS
pH	-0.239	-0.0036	8.598	NS
Organic carbon	0.242	0.0038	0.574	NS
Organic matter	0.243	0.0065	0.984	NS
Nitrogen	0.235	0.9612	230.503	NS
Phosphate	0.146	0.0375	5.359	NS
Potassium	0.112	2.0730	415.701	NS
Litter				
Apterygote				
Soil temperature	0.248	0.2509	24.789	NS
Soil moisture	0.076	0.0116	2.077	NS
Relative humidity	0.360	1.0017	63.744	NS
pH	0.289	0.0070	8.542	NS
Organic carbon	-0.367	-0.0092	0.639	NS
Organic matter	-0.357	-0.0153	1.094	NS
Nitrogen	-0.277	-1.8084	245.163	NS
Phosphate	-0.031	-0.0126	5.728	NS
Potassium	0.301	8.8990	402.520	NS
Litter				
Mites				
Soil temperature	-0.242	-0.0742	26.711	NS
Soil moisture	-0.134	-0.0062	2.205	NS
Relative humidity	0.097	0.0815	66.102	NS
pH	0.491	0.0036	8.516	NS
Organic carbon	0.047	0.0004	0.602	NS
Organic matter	0.055	0.0007	1.031	NS
Nitrogen	0.091	0.1795	236.305	NS
Phosphate	0.248	0.0308	5.251	NS
Potassium	-0.092	-0.8243	445.275	NS

** = significant at 5% only; ** = significant at 5% and 1%; NS = not significant*

Table 19b: Relationship between Insectan population and Acarine population with edaphic factors at the site of Mango Orchards during 2009-10

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.593	0.2862	17.81	*
Soil moisture	-0.334	-0.0195	2.49	NS
Relative humidity	0.429	0.4407	55.13	NS
pH	0.030	0.0002	8.94	NS
Organic carbon	0.584	0.0082	0.51	*
Organic matter	0.584	0.0140	0.88	*
Nitrogen	0.596	2.1332	207.87	*
Phosphate	0.298	0.0624	8.48	NS
Potassium	-0.172	-1.7945	453.49	NS
0–5 cm				
Apterygote				
Soil temperature	-0.684	-0.0289	30.28	*
Soil moisture	0.500	0.0026	1.57	NS
Relative humidity	-0.223	-0.0200	71.44	NS
pH	0.117	0.0001	8.94	NS
Organic carbon	-0.410	-0.0005	0.83	NS
Organic matter	-0.407	-0.0009	1.42	NS
Nitrogen	-0.456	-0.1428	292.22	NS
Phosphate	-0.404	-0.0074	11.33	NS
Potassium	0.374	0.3414	356.49	NS
0–5 cm				
Mites				
Soil temperature	-0.446	-0.1187	31.22	NS
Soil moisture	0.480	0.0154	1.31	NS
Relative humidity	0.528	0.2987	58.16	NS
pH	-0.168	-0.0006	8.97	NS
Organic carbon	0.221	0.0017	0.71	NS
Organic matter	0.219	0.0029	1.22	NS
Nitrogen	0.205	0.4037	260.65	NS
Phosphate	0.431	0.0497	8.64	NS
Potassium	0.087	0.4991	378.41	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
<u>Pterygote</u>				
Soil temperature	0.546	0.1669	20.53	NS
Soil moisture	-0.443	-0.0164	2.49	NS
Relative humidity	0.292	0.1898	61.87	NS
pH	-0.179	-0.0008	8.98	NS
Organic carbon	0.318	0.0028	0.66	NS
Organic matter	0.318	0.0048	1.14	NS
Nitrogen	0.323	0.7308	247.65	NS
Phosphate	0.108	0.0143	9.92	NS
Potassium	-0.520	-3.4306	527.03	NS
5–10 cm				
<u>Apterygote</u>				
Soil temperature	-0.659	-0.0799	30.32	*
Soil moisture	0.558	0.0082	1.52	NS
Relative humidity	-0.002	-0.0006	69.11	NS
pH	0.168	0.0003	8.94	NS
Organic carbon	-0.376	-0.0013	0.83	NS
Organic matter	-0.378	-0.0023	1.42	NS
Nitrogen	-0.424	-0.3807	291.82	NS
Phosphate	-0.319	-0.0167	11.18	NS
Potassium	0.440	1.1496	347.14	NS
5–10 cm				
<u>Mites</u>				
Soil temperature	-0.291	-0.1007	29.59	NS
Soil moisture	0.576	0.0241	1.22	*
Relative humidity	0.537	0.3946	58.46	NS
pH	-0.187	-0.0009	8.97	NS
Organic carbon	0.635	0.0064	0.60	*
Organic matter	0.630	0.0108	1.03	*
Nitrogen	0.623	1.5970	232.43	*
Phosphate	0.787	0.1179	7.29	**
Potassium	0.354	2.6393	325.62	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
Litter				
<u>Pterygote</u>				
Soil temperature	0.121	0.0873	25.84	NS
Soil moisture	-0.604	-0.0528	2.50	*
Relative humidity	-0.537	-0.8251	78.85	NS
pH	0.090	0.0009	8.94	NS
Organic carbon	-0.177	-0.0037	0.81	NS
Organic matter	-0.170	-0.0061	1.40	NS
Nitrogen	-0.182	-0.9763	286.97	NS
Phosphate	-0.111	-0.0346	10.87	NS
Potassium	-0.405	-6.3221	471.48	NS
Litter				
<u>Apterygote</u>				
Soil temperature	-0.441	-0.0492	28.06	NS
Soil moisture	0.500	0.0067	1.71	NS
Relative humidity	0.230	0.0546	67.77	NS
pH	0.436	0.0007	8.93	NS
Organic carbon	-0.174	-0.0006	0.78	NS
Organic matter	-0.166	-0.0009	1.35	NS
Nitrogen	-0.190	-0.1574	279.21	NS
Phosphate	-0.267	-0.0129	10.77	NS
Potassium	0.249	0.6003	382.21	NS
Litter				
<u>Mites</u>				
Soil temperature	0.377	0.0213	24.95	NS
Soil moisture	0.226	0.0015	1.73	NS
Relative humidity	0.604	0.0726	62.52	*
pH	0.109	0.0001	8.94	NS
Organic carbon	0.781	0.0013	0.66	**
Organic matter	0.780	0.0022	1.12	**
Nitrogen	0.789	0.3307	245.49	**
Phosphate	0.485	0.0119	9.39	NS
Potassium	0.202	0.2460	374.41	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Table 20a: Relationship between Insectan population and Acarine population with edaphic factors at the site of Teak Plantation during 2008-09

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.670	0.1931	21.53	*
Soil moisture	-0.461	-0.0280	3.43	NS
Relative humidity	0.467	0.3084	56.68	NS
pH	-0.068	-0.0011	9.12	NS
Organic carbon	0.443	0.0038	0.38	NS
Organic matter	0.446	0.0066	0.65	NS
Nitrogen	0.445	1.1109	171.88	NS
Phosphate	-0.618	-0.0474	6.40	*
Potassium	-0.242	-0.6502	450.31	NS
0–5 cm				
Apterygote				
Soil temperature	-0.063	-0.0091	26.65	NS
Soil moisture	-0.209	-0.0064	2.92	NS
Relative humidity	-0.242	-0.0804	66.87	NS
pH	-0.791	-0.0067	9.30	**
Organic carbon	0.471	0.0020	0.41	NS
Organic matter	0.465	0.0035	0.70	NS
Nitrogen	0.311	0.3903	187.81	NS
Phosphate	0.005	0.0002	5.21	NS
Potassium	0.338	0.4575	420.01	NS
0–5 cm				
Mites				
Soil temperature	-0.017	-0.0112	26.55	NS
Soil moisture	0.318	0.0447	2.03	NS
Relative humidity	0.591	0.9053	50.38	*
pH	0.023	0.0009	9.08	NS
Organic carbon	0.049	0.0010	0.46	NS
Organic matter	0.052	0.0018	0.78	NS
Nitrogen	0.024	0.1405	197.57	NS
Phosphate	0.139	0.0248	4.83	NS
Potassium	0.168	1.0470	417.77	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
Pterygote				
Soil temperature	0.725	0.2214	20.73	**
Soil moisture	-0.402	-0.0258	3.38	NS
Relative humidity	-0.022	-0.0155	64.81	NS
pH	0.154	0.0028	9.02	NS
Organic carbon	0.271	0.0025	0.41	NS
Organic matter	0.272	0.0043	0.70	NS
Nitrogen	0.361	0.9548	175.40	NS
Phosphate	-0.335	-0.0272	5.91	NS
Potassium	-0.082	-0.2327	439.93	NS
5–10 cm				
Apterygote				
Soil temperature	0.243	0.2014	25.30	NS
Soil moisture	-0.494	-0.0862	3.19	NS
Relative humidity	-0.442	-0.8385	68.89	NS
pH	-0.905	-0.0439	9.33	**
Organic carbon	0.758	0.0188	0.37	**
Organic matter	0.752	0.0321	0.64	**
Nitrogen	0.659	4.7302	174.52	*
Phosphate	-0.295	-0.0650	5.56	NS
Potassium	0.283	2.1832	422.36	NS
5–10 cm				
Mites				
Soil temperature	0.131	0.1334	24.99	NS
Soil moisture	0.082	0.0177	2.54	NS
Relative humidity	0.568	1.3250	50.61	NS
pH	-0.238	-0.0142	9.24	NS
Organic carbon	0.342	0.0104	0.36	NS
Organic matter	0.343	0.0180	0.62	NS
Nitrogen	0.288	2.5363	173.33	NS
Phosphate	-0.266	-0.0722	5.97	NS
Potassium	0.004	0.0392	433.59	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
Litter				
Pterygote				
Soil temperature	0.515	0.2424	23.41	NS
Soil moisture	-0.765	-0.0758	3.66	**
Relative humidity	-0.539	-0.5815	71.54	NS
pH	-0.264	-0.0073	9.18	NS
Organic carbon	0.234	0.0033	0.43	NS
Organic matter	0.227	0.0055	0.74	NS
Nitrogen	0.240	0.9775	187.78	NS
Phosphate	-0.550	-0.0689	6.06	NS
Potassium	-0.201	-0.8801	444.78	NS
Litter				
Apterygote				
Soil temperature	0.272	0.3294	25.06	NS
Soil moisture	-0.523	-0.1333	3.26	NS
Relative humidity	-0.232	-0.6429	66.99	NS
pH	-0.833	-0.0591	9.33	**
Organic carbon	0.678	0.0246	0.38	*
Organic matter	0.671	0.0418	0.64	*
Nitrogen	0.572	6.0040	175.73	NS
Phosphate	-0.227	-0.0731	5.51	NS
Potassium	0.216	2.4444	424.22	NS
Litter				
Mites				
Soil temperature	0.197	0.0477	25.69	NS
Soil moisture	0.056	0.0029	2.69	NS
Relative humidity	0.594	0.3296	59.67	*
pH	0.045	0.0006	9.08	NS
Organic carbon	0.178	0.0013	0.45	NS
Organic matter	0.184	0.0023	0.78	NS
Nitrogen	0.155	0.3254	195.06	NS
Phosphate	-0.356	-0.0229	5.55	NS
Potassium	-0.101	-0.2283	437.29	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Table 20b: Relationship between Insectan population and Acarine population with edaphic factors at the site of Teak Plantation during 2009-10

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.721	0.0932	20.10	**
Soil moisture	-0.408	-0.0088	2.80	NS
Relative humidity	0.053	0.0262	66.85	NS
pH	0.686	0.0029	9.24	*
Organic carbon	-0.144	-0.0005	0.46	NS
Organic matter	-0.153	-0.0010	0.79	NS
Nitrogen	-0.059	-0.0787	191.29	NS
Phosphate	-0.424	-0.0198	10.42	NS
Potassium	-0.624	-0.7209	472.57	*
0–5 cm				
Apterygote				
Soil temperature	-0.327	-0.0184	26.05	NS
Soil moisture	0.513	0.0048	2.07	NS
Relative humidity	-0.208	-0.0451	70.62	NS
pH	-0.865	-0.0016	9.48	**
Organic carbon	-0.299	-0.0005	0.46	NS
Organic matter	-0.299	-0.0008	0.79	NS
Nitrogen	-0.476	-0.2764	201.64	NS
Phosphate	0.454	0.0092	8.87	NS
Potassium	0.371	0.1869	424.16	NS
0–5 cm				
Mites				
Soil temperature	0.372	0.0419	22.96	NS
Soil moisture	-0.329	-0.0062	2.64	NS
Relative humidity	0.027	0.0115	67.67	NS
pH	0.141	0.0005	9.37	NS
Organic carbon	0.174	0.0006	0.40	NS
Organic matter	0.173	0.0010	0.69	NS
Nitrogen	0.126	0.1467	179.66	NS
Phosphate	0.247	0.0101	8.85	NS
Potassium	-0.057	-0.0575	436.91	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
<u>Pterygote</u>				
Soil temperature	0.686	0.1232	20.61	*
Soil moisture	-0.332	-0.0100	2.69	NS
Relative humidity	0.103	0.0709	65.67	NS
pH	0.642	0.0038	9.25	*
Organic carbon	-0.220	-0.0011	0.47	NS
Organic matter	-0.231	-0.0020	0.82	NS
Nitrogen	-0.127	-0.2344	195.60	NS
Phosphate	-0.301	-0.0195	10.07	NS
Potassium	-0.472	-0.7573	461.52	NS
5–10 cm				
<u>Apterygote</u>				
Soil temperature	-0.424	-0.1750	26.91	NS
Soil moisture	0.363	0.0251	2.07	NS
Relative humidity	-0.253	-0.4017	72.43	NS
pH	-0.828	-0.0112	9.51	**
Organic carbon	-0.009	-0.0001	0.43	NS
Organic matter	-0.009	-0.0002	0.74	NS
Nitrogen	-0.169	-0.7189	194.57	NS
Phosphate	0.528	0.0787	8.54	NS
Potassium	0.225	0.8305	425.35	NS
5–10 cm				
<u>Mites</u>				
Soil temperature	0.473	0.1395	21.67	NS
Soil moisture	-0.001	-0.0001	2.33	NS
Relative humidity	0.258	0.2925	61.08	NS
pH	0.168	0.0016	9.35	NS
Organic carbon	0.139	0.0012	0.40	NS
Organic matter	0.135	0.0020	0.69	NS
Nitrogen	0.082	0.2475	181.02	NS
Phosphate	0.352	0.0375	8.44	NS
Potassium	0.009	0.0225	433.45	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd……………

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
Litter				
<u>Pterygote</u>				
Soil temperature	0.249	0.0678	23.94	NS
Soil moisture	-0.262	-0.0119	2.53	NS
Relative humidity	-0.506	-0.5311	77.19	NS
pH	-0.100	-0.0009	9.41	NS
Organic carbon	0.147	0.0011	0.41	NS
Organic matter	0.143	0.0019	0.71	NS
Nitrogen	0.045	0.1271	184.94	NS
Phosphate	0.191	0.0188	9.04	NS
Potassium	-0.398	-0.9694	450.32	NS
Litter				
<u>Apterygote</u>				
Soil temperature	-0.590	-0.3386	27.37	*
Soil moisture	0.269	0.0259	2.15	NS
Relative humidity	-0.002	-0.0053	68.29	NS
pH	-0.713	-0.0134	9.48	**
Organic carbon	0.194	0.0032	0.41	NS
Organic matter	0.195	0.0055	0.70	NS
Nitrogen	0.051	0.2990	185.07	NS
Phosphate	0.363	0.0754	8.85	NS
Potassium	0.380	1.9487	420.85	NS
Litter				
<u>Mites</u>				
Soil temperature	0.426	0.0338	22.76	NS
Soil moisture	0.033	0.0004	2.30	NS
Relative humidity	0.546	0.1670	56.80	NS
pH	0.525	0.0014	9.30	NS
Organic carbon	0.025	0.0001	0.43	NS
Organic matter	0.020	0.0001	0.74	NS
Nitrogen	0.079	0.0648	182.64	NS
Phosphate	0.075	0.0022	9.21	NS
Potassium	-0.013	-0.0090	434.62	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Table 21a: Relationship between Insectan population and Acarine population with edaphic factors at the site of Unarable Land during 2008-09

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.575	0.0930	21.63	NS
Soil moisture	0.504	0.0157	1.57	NS
Relative humidity	0.439	0.2121	50.66	NS
pH	0.448	0.0026	9.27	NS
Organic carbon	-0.748	-0.0024	0.82	**
Organic matter	-0.739	-0.0040	1.40	**
Nitrogen	-0.711	-0.6540	292.03	**
Phosphate	-0.250	-0.0110	10.88	NS
Potassium	-0.359	-1.2011	545.00	NS
0–5 cm				
Apterygote				
Soil temperature	-0.334	-0.0089	28.17	NS
Soil moisture	0.345	0.0018	2.37	NS
Relative humidity	-0.356	-0.0285	66.33	NS
pH	-0.593	-0.0006	9.48	*
Organic carbon	0.093	0.0000	0.67	NS
Organic matter	0.099	0.0001	1.15	NS
Nitrogen	0.070	0.0107	250.92	NS
Phosphate	0.233	0.0017	10.04	NS
Potassium	0.162	0.0896	462.98	NS
0–5 cm				
Mites				
Soil temperature	-0.279	-0.0651	29.97	NS
Soil moisture	0.392	0.0176	1.83	NS
Relative humidity	-0.156	-0.1088	68.06	NS
pH	-0.180	-0.0015	9.49	NS
Organic carbon	-0.331	-0.0015	0.74	NS
Organic matter	-0.323	-0.0025	1.26	NS
Nitrogen	-0.408	-0.5422	273.83	NS
Phosphate	-0.632	-0.0401	11.82	*
Potassium	-0.384	-1.8500	546.11	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
Pterygote				
Soil temperature	0.558	0.2445	20.32	NS
Soil moisture	0.575	0.0485	1.15	NS
Relative humidity	0.466	0.6106	46.16	NS
pH	0.614	0.0097	9.15	*
Organic carbon	-0.681	-0.0059	0.84	*
Organic matter	-0.675	-0.0099	1.44	*
Nitrogen	-0.659	-1.6441	299.05	*
Phosphate	-0.250	-0.0298	11.06	NS
Potassium	-0.332	-3.0093	557.60	NS
5–10 cm				
Apterygote				
Soil temperature	-0.276	-0.0418	27.95	NS
Soil moisture	0.330	0.0096	2.39	NS
Relative humidity	-0.349	-0.1576	66.00	NS
pH	-0.543	-0.0029	9.47	NS
Organic carbon	0.066	0.0002	0.67	NS
Organic matter	0.078	0.0004	1.15	NS
Nitrogen	0.074	0.0640	250.97	NS
Phosphate	0.193	0.0079	10.08	NS
Potassium	0.121	0.3781	465.73	NS
5–10 cm				
Mites				
Soil temperature	0.279	0.2173	25.47	NS
Soil moisture	0.623	0.0935	1.73	*
Relative humidity	0.101	0.2352	61.65	NS
pH	-0.131	-0.0037	9.46	NS
Organic carbon	-0.733	-0.0112	0.77	**
Organic matter	-0.743	-0.0194	1.32	**
Nitrogen	-0.741	-3.2869	280.13	**
Phosphate	0.142	0.0301	9.94	NS
Potassium	-0.220	-3.5478	501.79	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Table 21b: Relationship between Insectan population and Acarine population with edaphic factors at the site of Unarable Land during 2009-10

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.392	0.0539	24.78	NS
Soil moisture	-0.240	-0.0059	2.71	NS
Relative humidity	0.053	0.0235	58.13	NS
pH	0.029	0.0001	9.65	NS
Organic carbon	-0.059	-0.0001	0.73	NS
Organic matter	-0.081	-0.0001	1.25	NS
Nitrogen	0.004	0.0014	267.46	NS
Phosphate	0.506	0.0222	7.40	NS
Potassium	0.096	0.1982	529.55	NS
0–5 cm				
Apterygote				
Soil temperature	-0.193	-0.0104	29.94	NS
Soil moisture	0.499	0.0048	1.90	NS
Relative humidity	-0.215	-0.0375	62.57	NS
pH	-0.537	-0.0009	9.72	NS
Organic carbon	-0.077	0.0000	0.72	NS
Organic matter	-0.079	-0.0001	1.24	NS
Nitrogen	-0.016	-0.0021	267.72	NS
Phosphate	0.269	0.0046	8.93	NS
Potassium	0.091	0.0737	541.12	NS
0–5 cm				
Mites				
Soil temperature	-0.556	-0.0382	32.99	NS
Soil moisture	0.244	0.0030	1.92	NS
Relative humidity	0.108	0.0239	57.74	NS
pH	-0.290	-0.0006	9.72	NS
Organic carbon	-0.561	-0.0003	0.75	NS
Organic matter	-0.556	-0.0005	1.29	NS
Nitrogen	-0.556	-0.0915	276.54	NS
Phosphate	0.102	0.0022	9.02	NS
Potassium	0.159	0.1639	529.95	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd...............

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
Pterygote				
Soil temperature	0.435	0.0547	26.21	NS
Soil moisture	-0.546	-0.0123	2.90	NS
Relative humidity	-0.184	-0.0746	64.24	NS
pH	0.352	0.0013	9.58	NS
Organic carbon	0.342	0.0003	0.70	NS
Organic matter	0.332	0.0005	1.21	NS
Nitrogen	0.448	0.1348	260.08	NS
Phosphate	-0.401	-0.0161	10.13	NS
Potassium	0.310	0.5843	513.47	NS
5–10 cm				
Apterygote				
Soil temperature	-0.594	-0.1416	31.83	*
Soil moisture	0.626	0.0268	1.73	*
Relative humidity	0.174	0.1343	57.63	NS
pH	-0.202	-0.0015	9.69	NS
Organic carbon	0.103	0.0002	0.72	NS
Organic matter	0.090	0.0003	1.23	NS
Nitrogen	0.187	0.1068	265.63	NS
Phosphate	0.460	0.0349	8.60	NS
Potassium	0.056	0.2014	542.32	NS
5–10 cm				
Mites				
Soil temperature	-0.249	-0.0612	31.55	NS
Soil moisture	-0.075	-0.0033	2.34	NS
Relative humidity	-0.219	-0.1742	66.63	NS
pH	0.223	0.0017	9.60	NS
Organic carbon	-0.463	-0.0009	0.75	NS
Organic matter	-0.464	-0.0015	1.30	NS
Nitrogen	-0.409	-0.2408	276.63	NS
Phosphate	0.489	0.0383	7.80	NS
Potassium	-0.099	-0.3634	559.66	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Table 22a: Relationship between Insectan population and Acarine population with edaphic factors at the site of Wheat Field during 2008-09

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.648	0.1193	21.51	*
Soil moisture	0.449	0.0145	1.38	NS
Relative humidity	0.006	0.0039	65.75	NS
pH	0.567	0.0060	9.09	NS
Organic carbon	0.138	0.0010	0.41	NS
Organic matter	0.346	0.0044	0.54	NS
Nitrogen	0.120	0.1412	142.36	NS
Phosphate	0.326	0.0160	10.28	NS
Potassium	-0.215	-0.4041	464.84	NS
0–5 cm				
Apterygote				
Soil temperature	0.544	0.4532	24.06	NS
Soil moisture	0.543	0.0792	1.55	NS
Relative humidity	0.386	1.1692	59.29	NS
pH	0.541	0.0261	9.20	NS
Organic carbon	0.045	0.0015	0.44	NS
Organic matter	0.193	0.0112	0.66	NS
Nitrogen	0.193	1.0287	142.59	NS
Phosphate	-0.074	-0.0164	11.06	NS
Potassium	0.062	0.5277	444.51	NS
0–5 cm				
Mites				
Soil temperature	0.579	0.2361	24.30	*
Soil moisture	0.404	0.0289	1.71	NS
Relative humidity	0.502	0.7456	58.59	NS
pH	0.498	0.0118	9.23	NS
Organic carbon	-0.006	-0.0001	0.45	NS
Organic matter	0.118	0.0034	0.69	NS
Nitrogen	0.060	0.1574	146.87	NS
Phosphate	-0.133	-0.0144	11.11	NS
Potassium	-0.066	-0.2759	450.21	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
Pterygote				
Soil temperature	0.767	0.2165	21.43	**
Soil moisture	0.642	0.0318	1.24	*
Relative humidity	0.244	0.2505	59.90	NS
pH	0.773	0.0126	9.05	**
Organic carbon	0.210	0.0023	0.39	NS
Organic matter	0.389	0.0076	0.54	NS
Nitrogen	0.191	0.3454	140.13	NS
Phosphate	0.011	0.0009	10.95	NS
Potassium	-0.067	-0.1931	452.14	NS
5–10 cm				
Apterygote				
Soil temperature	0.609	0.5905	23.97	*
Soil moisture	0.422	0.0717	1.68	NS
Relative humidity	0.351	1.2393	60.34	NS
pH	0.527	0.0296	9.22	NS
Organic carbon	-0.062	-0.0024	0.46	NS
Organic matter	0.076	0.0051	0.70	NS
Nitrogen	-0.015	-0.0914	148.83	NS
Phosphate	-0.295	-0.0761	11.31	NS
Potassium	-0.016	-0.1595	448.22	NS
5–10 cm				
Mites				
Soil temperature	0.709	0.3829	23.15	**
Soil moisture	0.453	0.0429	1.61	NS
Relative humidity	0.231	0.4549	61.78	NS
pH	0.619	0.0194	9.17	*
Organic carbon	-0.029	-0.0006	0.46	NS
Organic matter	0.091	0.0034	0.70	NS
Nitrogen	-0.047	-0.1610	149.88	NS
Phosphate	-0.317	-0.0455	11.38	NS
Potassium	0.007	0.0368	447.17	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Table 22b: Relationship between Insectan population and Acarine population with edaphic factors at the site of Wheat Field during 2009-10

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
0–5 cm				
Pterygote				
Soil temperature	0.651	0.1133	21.93	*
Soil moisture	0.468	0.0147	0.96	NS
Relative humidity	-0.385	-0.1731	75.32	NS
pH	0.760	0.0073	9.01	**
Organic carbon	0.456	0.0028	0.27	NS
Organic matter	0.452	0.0048	0.45	NS
Nitrogen	0.564	0.4755	119.74	NS
Phosphate	0.425	0.0224	8.13	NS
Potassium	0.031	0.0639	453.77	NS
0–5 cm				
Apterygote				
Soil temperature	0.410	0.1351	26.03	NS
Soil moisture	-0.177	-0.0105	1.95	NS
Relative humidity	0.224	0.1912	62.53	NS
pH	0.572	0.0104	9.25	NS
Organic carbon	-0.229	-0.0026	0.46	NS
Organic matter	-0.234	-0.0047	0.80	NS
Nitrogen	-0.008	-0.0128	146.46	NS
Phosphate	0.317	0.0317	8.86	NS
Potassium	-0.378	-1.4570	481.25	NS
0–5 cm				
Mites				
Soil temperature	0.601	0.9732	25.01	*
Soil moisture	0.060	0.0175	1.72	NS
Relative humidity	-0.096	-0.4000	67.00	NS
pH	0.746	0.0668	9.19	**
Organic carbon	-0.005	-0.0003	0.42	NS
Organic matter	-0.010	-0.0010	0.72	NS
Nitrogen	0.207	1.6244	140.84	NS
Phosphate	0.237	0.1164	8.99	NS
Potassium	-0.231	-4.3707	471.90	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Contd................

Variable	Correlation Coefficient (r)	Slope (m)	Intercept (c)	Significance
5–10 cm				
<u>Pterygote</u>				
Soil temperature	0.802	0.1271	21.12	**
Soil moisture	0.285	0.0081	1.32	NS
Relative humidity	-0.382	-0.1565	74.44	NS
pH	0.878	0.0077	8.98	**
Organic carbon	0.320	0.0018	0.32	NS
Organic matter	0.317	0.0030	0.55	NS
Nitrogen	0.523	0.4015	123.73	NS
Phosphate	0.261	0.0125	8.68	NS
Potassium	-0.011	-0.0203	458.47	NS
5–10 cm				
<u>Apterygote</u>				
Soil temperature	0.296	0.0968	26.58	NS
Soil moisture	-0.208	-0.0122	1.99	NS
Relative humidity	0.284	0.2396	61.53	NS
pH	0.460	0.0083	9.27	NS
Organic carbon	-0.212	-0.0024	0.46	NS
Organic matter	-0.218	-0.0043	0.79	NS
Nitrogen	-0.039	-0.0618	147.32	NS
Phosphate	0.359	0.0355	8.77	NS
Potassium	-0.333	-1.2749	479.33	NS
5–10 cm				
<u>Mites</u>				
Soil temperature	0.671	0.7854	23.67	*
Soil moisture	0.208	0.0437	1.52	NS
Relative humidity	-0.122	-0.3694	67.82	NS
pH	0.858	0.0555	9.09	**
Organic carbon	0.221	0.0090	0.37	NS
Organic matter	0.216	0.0154	0.63	NS
Nitrogen	0.434	2.4592	131.90	NS
Phosphate	0.316	0.1117	8.73	NS
Potassium	-0.245	-3.3529	476.89	NS

* = significant at 5% only; ** = significant at 5% and 1%; NS = not significant

Table 23a: Monthly variations in species diversity of Pterygote insects of the site Mango Orchard represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09						Year 2009-10					
	0 – 5 cm		5 – 10 cm		Litter		0 – 5 cm		5 – 10 cm		Litter	
	H'	J	H'	J	H'	J	H'	J	H'	J	H'	J
Mar	1.542	0.861	1.185	0.410	1.144	0.422	1.440	0.601	1.019	0.289	1.143	0.412
Apr	1.488	0.765	1.047	0.421	1.040	0.750	1.187	0.478	0.766	0.244	0.803	0.349
May	1.142	0.433	0.943	0.409	0.916	0.369	0.877	0.249	0.773	0.196	1.074	0.667
Jun	1.324	0.575	0.655	0.337	0.598	0.372	0.882	0.318	0.690	0.214	0.824	0.396
Jul	1.304	0.435	1.259	0.605	0.000	0.000	1.241	0.401	0.944	0.301	1.040	1.500
Aug	1.010	0.373	1.261	0.574	0.900	0.559	0.916	0.288	0.947	0.257	0.900	0.559
Sep	0.760	0.365	1.358	0.980	0.598	0.372	0.935	0.267	0.727	0.197	0.000	0.000
Oct	0.377	0.194	0.673	0.613	0.693	0.000	1.174	0.473	0.806	0.305	0.842	0.351
Nov	1.072	0.551	1.011	0.921	0.950	0.865	1.060	0.442	1.354	0.651	0.693	1.000
Dec	0.736	0.193	1.011	0.921	0.000	0.000	0.760	0.365	0.868	0.626	0.000	0.000
Jan	0.000	0.000	0.562	0.512	0.693	0.000	0.849	0.474	1.004	0.914	0.562	0.512
Feb	1.058	0.590	0.849	0.474	0.721	0.328	0.970	0.350	0.890	0.329	0.234	0.086

Table 23b: Monthly variations in species diversity of Apterygote insects of the site Mango Orchard represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09						Year 2009-10					
	0 – 5 cm		5 – 10 cm		Litter		0 – 5 cm		5 – 10 cm		Litter	
	H'	J	H'	J	H'	J	H'	J	H'	J	H'	J
Mar	0.705	0.151	0.610	0.172	0.000	0.000	0.352	0.062	0.390	0.097	0.000	0.000
Apr	0.451	0.196	0.600	0.273	0.637	0.918	0.693	0.000	0.693	1.000	0.000	0.000
May	1.099	0.683	1.040	1.500	0.693	0.000	1.332	1.922	0.000	0.000	0.000	0.000
Jun	0.693	0.000	0.637	0.918	0.000	0.000	0.000	0.000	0.000	0.000	0.637	0.918
Jul	0.000	0.000	0.000	0.000	0.910	0.366	0.295	0.097	0.637	0.918	0.989	0.307
Aug	0.950	0.865	1.055	1.522	1.099	0.000	1.055	0.761	1.011	0.921	1.040	1.500
Sep	0.637	0.459	0.562	0.512	0.000	0.000	0.736	0.411	0.000	0.000	0.693	0.000
Oct	0.673	0.613	0.000	0.000	0.000	0.000	0.693	1.000	0.693	0.000	0.000	0.000
Nov	0.693	0.000	0.562	0.512	0.693	0.000	1.024	0.399	0.682	0.192	0.637	0.459
Dec	0.693	0.256	0.000	0.000	0.000	0.000	0.143	0.024	0.351	0.077	0.383	0.072
Jan	0.644	0.178	0.802	0.412	0.000	0.000	0.368	0.061	0.447	0.099	0.000	0.000
Feb	0.278	0.060	0.398	0.093	0.693	0.000	0.748	0.159	0.752	0.165	0.000	0.000

Table 23c: Monthly variations in species diversity of Mites of the site Mango Orchard represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09						Year 2009-10					
	0 – 5 cm		5 – 10 cm		Litter		0 – 5 cm		5 – 10 cm		Litter	
	H'	J	H'	J	H'	J	H'	J	H'	J	H'	J
Mar	1.024	0.492	0.349	0.168	0.637	0.918	0.984	0.340	0.687	0.298	0.000	0.000
Apr	0.628	0.253	0.000	0.000	0.000	0.000	0.668	0.241	0.662	0.411	0.000	0.000
May	0.647	0.187	0.410	0.165	0.325	0.112	0.532	0.135	0.716	0.235	0.338	0.078
Jun	0.500	0.361	0.000	0.000	0.637	0.918	0.000	0.000	0.000	0.000	0.693	0.000
Jul	0.271	0.085	0.191	0.064	0.163	0.051	0.139	0.040	0.279	0.089	0.378	0.068
Aug	0.680	0.220	0.234	0.069	0.393	0.121	0.569	0.169	0.382	0.103	0.239	0.041
Sep	0.451	0.150	0.580	0.188	0.787	0.317	0.466	0.140	0.601	0.173	0.645	0.134
Oct	0.000	0.000	0.562	0.512	0.000	0.000	0.444	0.164	0.598	0.260	0.937	0.346
Nov	0.440	0.144	0.000	0.000	0.000	0.000	0.480	0.110	0.624	0.154	0.642	0.195
Dec	0.000	0.000	0.693	0.000	0.637	0.459	0.631	0.161	0.479	0.155	0.494	0.125
Jan	0.578	0.219	0.451	0.280	0.500	0.361	0.179	0.058	0.456	0.150	1.099	1.585
Feb	0.673	0.271	0.790	0.259	1.051	0.319	0.000	0.000	0.000	0.000	0.000	0.000

Table 24a: Monthly variations in species diversity of Pterygote insects of the site Teak Plantation represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09						Year 2009-10					
	0 – 5 cm		5 – 10 cm		Litter		0 – 5 cm		5 – 10 cm		Litter	
	H'	J	H'	J	H'	J	H'	J	H'	J	H'	J
Mar	1.208	0.525	1.129	0.454	1.123	0.468	1.276	0.460	1.034	0.392	1.211	0.582
Apr	0.979	0.346	0.926	0.373	1.310	0.596	1.218	0.414	1.220	0.509	0.930	0.254
May	1.299	0.564	0.876	0.288	0.858	0.267	1.373	0.438	1.073	0.396	0.858	0.233
Jun	1.231	0.513	1.033	0.416	0.943	0.586	0.951	0.234	1.279	0.499	1.010	0.486
Jul	1.218	0.388	1.116	0.372	1.055	1.522	1.248	0.417	1.216	0.474	0.736	0.411
Aug	1.170	0.368	0.963	0.283	0.000	0.000	1.065	0.261	0.864	0.217	0.611	0.231
Sep	1.059	0.354	1.172	0.369	0.658	0.265	0.994	0.230	1.006	0.275	0.000	0.000
Oct	0.900	0.391	0.938	0.276	0.530	0.272	1.013	0.245	0.937	0.238	0.684	0.351
Nov	0.000	0.000	0.650	0.229	0.000	0.000	0.693	0.387	0.469	0.150	0.000	0.000
Dec	0.956	0.689	0.000	0.000	0.950	0.865	0.000	0.000	0.234	0.086	0.000	0.000
Jan	0.693	0.000	0.000	0.000	0.000	0.000	0.637	0.918	0.000	0.000	0.000	0.000
Feb	1.330	1.918	0.500	0.361	1.277	1.162	0.562	0.512	0.000	0.000	0.000	0.000

Table 24b: Monthly variations in species diversity of Apterygote insects of the site Teak Plantation represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09						Year 2009-10					
	0 – 5 cm		5 – 10 cm		Litter		0 – 5 cm		5 – 10 cm		Litter	
	H'	J	H'	J	H'	J	H'	J	H'	J	H'	J
Mar	0.821	0.179	0.837	0.290	0.988	0.429	0.538	0.096	0.869	0.264	0.901	0.376
Apr	0.764	0.187	0.857	0.357	1.237	0.768	0.559	0.112	0.799	0.237	0.325	0.102
May	1.040	1.500	1.040	1.500	0.637	0.918	0.637	0.918	0.000	0.000	0.000	0.000
Jun	1.215	0.876	1.099	0.000	0.693	0.000	1.034	0.531	1.242	1.131	0.000	0.000
Jul	0.637	0.918	0.000	0.000	0.000	0.000	0.693	0.000	0.000	0.000	0.673	0.613
Aug	1.330	1.918	1.099	0.000	0.000	0.000	1.154	0.832	1.332	1.922	0.000	0.000
Sep	0.000	0.000	0.000	0.000	1.099	0.000	0.637	0.918	0.000	0.000	0.000	0.000
Oct	0.000	0.000	1.099	0.000	0.000	0.000	0.000	0.000	0.673	0.613	0.000	0.000
Nov	1.265	0.786	0.693	0.000	0.000	0.000	1.063	0.309	0.562	0.314	0.000	0.000
Dec	0.826	0.218	0.000	0.000	0.637	0.918	1.471	1.061	1.011	0.921	0.000	0.000
Jan	0.926	0.361	0.950	0.865	0.000	0.000	1.240	0.692	1.154	0.555	1.084	0.422
Feb	1.154	0.358	0.693	0.000	0.000	0.000	1.197	0.406	0.637	0.918	0.693	1.000

Table 24c: Monthly variations in species diversity of Mites of the site Teak Plantation represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09						Year 2009-10					
	0 – 5 cm		5 – 10 cm		Litter		0 – 5 cm		5 – 10 cm		Litter	
	H'	J	H'	J	H'	J	H'	J	H'	J	H'	J
Mar	0.656	0.274	1.058	0.590	1.055	1.522	0.626	0.181	1.022	0.377	1.035	0.532
Apr	0.500	0.201	0.271	0.109	0.637	0.459	0.603	0.174	0.333	0.102	0.377	0.194
May	0.950	0.865	0.693	0.000	0.562	0.512	1.063	0.428	0.637	0.918	0.500	0.361
Jun	0.451	0.280	0.566	0.246	1.040	1.500	0.418	0.115	0.594	0.210	0.693	0.000
Jul	0.598	0.186	0.470	0.157	0.670	0.167	0.449	0.088	0.411	0.101	0.551	0.110
Aug	0.501	0.173	0.000	0.000	0.341	0.086	0.496	0.133	0.000	0.000	0.288	0.059
Sep	0.679	0.349	0.500	0.361	0.000	0.000	0.000	0.000	0.179	0.058	0.619	0.132
Oct	0.662	0.287	0.586	0.282	0.000	0.000	0.211	0.051	0.245	0.093	0.357	0.082
Nov	0.683	0.328	0.000	0.000	0.684	0.351	0.521	0.139	0.349	0.110	0.261	0.055
Dec	0.483	0.188	0.598	0.372	0.451	0.280	0.224	0.054	0.598	0.221	0.229	0.067
Jan	0.451	0.280	0.562	0.256	0.637	0.918	0.377	0.194	0.000	0.000	0.281	0.080
Feb	0.586	0.192	0.974	0.703	0.637	0.918	0.970	0.467	0.995	0.618	0.600	0.200

Table 25a: Monthly variations in species diversity of Pterygote insects of the site Unarable Land represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09				Year 2009-10			
	0 – 5 cm		5 – 10 cm		0 – 5 cm		5 – 10 cm	
	H'	J	H'	J	H'	J	H'	J
Mar	1.152	0.425	1.224	0.589	1.077	0.294	0.885	0.313
Apr	1.475	0.641	1.136	0.493	1.149	0.345	0.734	0.157
May	1.283	0.444	1.099	0.396	1.178	0.435	0.692	0.227
Jun	1.081	0.318	0.903	0.302	1.113	0.331	0.314	0.086
Jul	1.246	0.327	0.982	0.289	1.235	0.294	1.047	0.277
Aug	1.231	0.323	0.905	0.302	1.317	0.370	0.644	0.157
Sep	1.100	0.298	0.869	0.301	1.181	0.302	0.911	0.210
Oct	1.283	0.358	0.882	0.318	1.217	0.277	0.824	0.331
Nov	1.014	0.338	0.846	0.368	0.985	0.215	1.137	0.410
Dec	1.021	0.353	1.304	0.566	1.033	0.317	0.808	0.270
Jan	1.368	0.594	1.051	0.438	0.911	0.287	0.960	0.493
Feb	0.863	0.228	1.410	0.678	1.091	0.358	1.055	0.589

Table 25b: Monthly variations in species diversity of Apterygote Insects of the site Unarable Land represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09				Year 2009-10			
	0 – 5 cm		5 – 10 cm		0 – 5 cm		5 – 10 cm	
	H'	J	H'	J	H'	J	H'	J
Mar	0.883	0.197	0.349	0.168	0.663	0.117	0.299	0.091
Apr	0.911	0.283	0.562	0.512	0.490	0.139	1.055	1.522
May	1.099	0.000	1.386	0.000	0.637	0.918	0.000	0.000
Jun	1.609	0.000	0.637	0.918	1.332	1.922	1.040	1.500
Jul	1.099	1.585	0.693	0.000	1.523	1.386	0.693	0.000
Aug	0.637	0.918	0.693	0.000	0.693	0.000	0.693	0.000
Sep	0.410	0.229	0.693	0.000	0.950	0.865	1.215	0.876
Oct	0.900	0.559	0.637	0.918	0.934	0.389	0.950	0.865
Nov	0.530	0.174	0.000	0.000	1.253	0.603	1.281	0.516
Dec	0.736	0.411	0.637	0.918	1.421	0.572	0.325	0.148
Jan	0.840	0.177	0.721	0.328	0.999	0.294	0.628	0.213
Feb	0.766	0.123	0.838	0.184	0.675	0.130	0.977	0.235

Table 25c: Monthly variations in species diversity of Mites of the site Unarable Land represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09				Year 2009-10			
	0 – 5 cm		5 – 10 cm		0 – 5 cm		5 – 10 cm	
	H'	J	H'	J	H'	J	H'	J
Mar	0.753	0.303	0.377	0.194	0.589	0.155	0.918	0.370
Apr	0.470	0.157	0.451	0.280	0.639	0.201	0.000	0.000
May	0.451	0.196	1.040	1.500	0.462	0.157	0.974	0.703
Jun	0.611	0.201	0.000	0.000	0.364	0.074	0.076	0.018
Jul	1.074	0.372	0.830	0.378	1.084	0.302	0.970	0.467
Aug	1.012	0.407	1.061	0.765	1.033	0.310	0.859	0.413
Sep	0.692	0.224	0.377	0.124	0.628	0.153	0.909	0.239
Oct	0.669	0.165	0.000	0.000	0.794	0.207	0.702	0.195
Nov	0.731	0.196	0.000	0.000	0.823	0.216	0.786	0.254
Dec	0.631	0.191	0.000	0.000	0.856	0.158	0.785	0.254
Jan	0.690	0.197	0.598	0.260	0.624	0.154	0.719	0.218
Feb	0.809	0.292	0.685	0.312	0.945	0.229	0.681	0.190

Table 26a: Monthly variations in species diversity of Pterygote insects of the site Wheat Field represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09				Year 2009-10			
	0 – 5 cm		5 – 10 cm		0 – 5 cm		5 – 10 cm	
	H'	J	H'	J	H'	J	H'	J
Mar	1.461	0.539	0.809	0.326	0.885	0.240	0.939	0.251
Apr	1.162	0.468	0.901	0.376	0.646	0.182	1.019	0.278
May	1.560	0.498	1.198	0.415	1.036	0.257	1.236	0.316
Jun	1.602	0.481	1.236	0.394	1.076	0.260	1.332	0.325
Jul	1.256	0.366	1.073	0.347	0.824	0.209	1.000	0.258
Aug	1.331	0.413	0.960	0.326	0.792	0.212	1.050	0.322
Sep	1.193	0.381	0.650	0.229	0.619	0.170	0.875	0.250
Oct	1.097	0.329	0.684	0.259	0.471	0.127	0.652	0.221
Nov	0.662	0.411	1.040	1.500	0.000	0.000	0.693	0.000
Dec	1.011	0.921	0.637	0.918	0.500	0.361	0.536	0.224
Jan	0.693	0.356	0.687	0.427	0.714	0.219	0.550	0.169
Feb	1.221	0.349	0.576	0.218	0.621	0.138	0.926	0.240

Table 26b: Monthly variations in species diversity of Apterygote insects of the site Wheat Field represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09				Year 2009-10			
	0 – 5 cm		5 – 10 cm		0 – 5 cm		5 – 10 cm	
	H'	J	H'	J	H'	J	H'	J
Mar	0.637	0.918	0.000	0.000	1.040	1.500	1.330	1.918
Apr	1.040	1.500	0.673	0.613	1.468	1.059	1.213	0.875
May	1.011	0.564	0.689	0.385	1.478	0.546	1.087	0.357
Jun	1.046	0.476	0.685	0.312	1.468	0.508	1.096	0.316
Jul	1.030	0.640	0.637	0.459	1.218	0.490	1.041	0.360
Aug	1.011	0.921	0.562	0.512	1.291	0.802	1.197	0.615
Sep	0.637	0.918	0.000	0.000	0.693	0.631	1.003	0.560
Oct	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000	0.637	0.918	0.637	0.918
Dec	0.000	0.000	0.000	0.000	0.900	0.559	0.000	0.000
Jan	0.000	0.000	0.637	0.459	0.837	0.337	0.846	0.251
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 26c: Monthly variations in species diversity of Mites of the site Wheat Field represented by Shannon-Wiener diversity index (H') & Evenness (J)

Months	Year 2008-09				Year 2009-10			
	0 – 5 cm		5 – 10 cm		0 – 5 cm		5 – 10 cm	
	H'	J	H'	J	H'	J	H'	J
Mar	0.693	0.000	1.040	1.500	0.000	0.000	0.451	0.280
Apr	1.040	1.500	1.093	0.679	0.637	0.918	0.500	0.361
May	1.004	0.380	1.092	0.525	0.662	0.411	0.637	0.306
Jun	1.042	0.376	1.090	0.455	0.679	0.349	0.662	0.287
Jul	1.060	0.510	0.992	0.510	0.673	0.613	0.586	0.282
Aug	1.061	0.765	0.974	0.703	0.637	0.918	0.673	0.613
Sep	1.055	1.522	0.673	0.613	0.000	0.000	0.693	1.000
Oct	0.000	0.000	0.637	0.918	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dec	0.000	0.000	0.000	0.000	0.693	0.000	0.000	0.000
Jan	0.879	0.354	0.598	0.372	0.000	0.000	0.637	0.918
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 27a: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	461.27	38.44	1.54
Between Rows	6	1080.50	180.08	7.22
Errors	72	1794.64	24.93	
Total	90	3336.42	243.45	

Table 27b: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	110.42	9.20	2.23
Between Rows	6	428.95	71.49	17.31
Errors	72	297.33	4.13	
Total	90	836.70	84.82	

Table 27c: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	104.38	8.70	2.14
Between Rows	6	194.74	32.46	8.00
Errors	72	292.12	4.06	
Total	90	591.24	45.21	

Table 27d: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	358.67	29.89	1.25
Between Rows	6	2240.95	373.49	15.60
Errors	72	1723.33	23.94	
Total	90	4322.95	427.32	

Table 27e: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	895.14	74.60	1.67
Between Rows	6	4979.90	829.98	18.57
Errors	72	3217.52	44.69	
Total	90	9092.57	949.27	

Table 27f: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	159.95	13.33	1.70
Between Rows	6	354.45	59.08	7.55
Errors	72	563.55	7.83	
Total	90	1077.95	80.23	

Table 28a: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	3682.38	306.86	1.27
Between Rows	5	4746.13	949.23	3.92
Errors	60	14546.38	242.44	
Total	77	22974.88	1498.53	

Table 28b: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1011.78	84.31	1.25
Between Rows	5	1053.11	210.62	3.11
Errors	60	4061.56	67.69	
Total	77	6126.44	362.63	

Table 28c: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	47.83	3.99	2.23
Between Rows	5	46.33	9.27	5.18
Errors	60	107.33	1.79	
Total	77	201.50	15.04	

Table 28d: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	54579.11	4548.26	1.16
Between Rows	5	97684.78	19536.96	5.00
Errors	60	234525.22	3908.75	
Total	77	386789.11	27993.97	

Table 28e: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	6642.49	553.54	1.70
Between Rows	5	9039.24	1807.85	5.54
Errors	60	19572.93	326.22	
Total	77	35254.65	2687.60	

Table 28f: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	7833.49	652.79	1.29
Between Rows	5	3793.40	758.68	1.50
Errors	60	30388.10	506.47	
Total	77	42014.99	1917.94	

Table 29a: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	443.22	36.94	1.39
Between Rows	2	1360.22	680.11	25.62
Errors	24	637.11	26.55	
Total	38	2440.56	743.59	

Table 29b: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	718.22	59.85	1.85
Between Rows	2	684.22	342.11	10.60
Errors	24	774.44	32.27	
Total	38	2176.89	434.23	

Table 29c: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Mango Orchard during 2008 - 09

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1045.64	87.14	2.41
Between Rows	2	309.72	154.86	4.29
Errors	24	866.28	36.09	
Total	38	2221.64	278.09	

Table 29d: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2753.64	229.47	1.70
Between Rows	2	5075.39	2537.69	18.77
Errors	24	3244.61	135.19	
Total	38	11073.64	2902.36	

Table 29e: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1632.31	136.03	2.11
Between Rows	2	2863.39	1431.69	22.24
Errors	24	1545.28	64.39	
Total	38	6040.97	1632.11	

Table 29f: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Mango Orchard during 2009 - 10

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	61010.33	5084.19	1.30
Between Rows	2	39883.17	19941.58	5.12
Errors	24	93563.50	3898.48	
Total	38	194457.00	28924.26	

Table 30a: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	636.70	53.06	2.27
Between Rows	6	848.00	141.33	6.04
Errors	72	1683.71	23.38	
Total	90	3168.42	217.78	

Table 30b: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	567.29	47.27	2.24
Between Rows	6	2049.62	341.60	16.22
Errors	72	1516.38	21.06	
Total	90	4133.29	409.94	

Table 30c: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	238.61	19.88	2.08
Between Rows	6	369.83	61.64	6.46
Errors	72	687.31	9.55	
Total	90	1295.75	91.07	

Table 30d: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2768.71	230.73	1.63
Between Rows	6	5542.45	923.74	6.52
Errors	72	10208.12	141.78	
Total	90	18519.29	1296.25	

Table 30e: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1436.67	119.72	1.77
Between Rows	6	3058.45	509.74	7.52
Errors	72	4879.83	67.78	
Total	90	9374.95	697.24	

Table 30f: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	623.10	51.92	1.61
Between Rows	6	620.07	103.35	3.20
Errors	72	2327.07	32.32	
Total	90	3570.24	187.59	

Table 31a: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2932.49	244.37	1.69
Between Rows	5	3316.57	663.31	4.58
Errors	60	8697.26	144.95	
Total	77	14946.32	1052.64	

Table 31b: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	89.78	7.48	1.63
Between Rows	5	73.94	14.79	3.22
Errors	60	275.39	4.59	
Total	77	439.11	26.86	

Table 31c: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	42.00	3.50	2.01
Between Rows	5	35.33	7.07	4.05
Errors	60	104.67	1.74	
Total	77	182.00	12.31	

Table 31d: Significance of population fluctuation of Aterygote insects as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	17031.44	1419.29	1.34
Between Rows	5	14544.94	2908.99	2.75
Errors	60	63492.06	1058.20	
Total	77	95068.44	5386.48	

Table 31e: Significance of population fluctuation of Aterygote insects as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	317.49	26.46	1.68
Between Rows	5	323.07	64.61	4.09
Errors	60	947.43	15.79	
Total	77	1587.99	106.86	

Table 31f: Significance of population fluctuation of Aterygote insects as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	164.04	13.67	1.37
Between Rows	5	102.13	20.43	2.04
Errors	60	599.71	10.00	
Total	77	865.88	44.09	

Table 32a: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	276.33	23.03	1.51
Between Rows	2	738.50	369.25	24.20
Errors	24	366.17	15.26	
Total	38	1381.00	407.53	

Table 32b: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	118.97	9.91	1.02
Between Rows	2	403.72	201.86	20.68
Errors	24	234.28	9.76	
Total	38	756.97	221.54	

Table 32c: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Teak Plantation during 2008 - 09

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2105.64	175.47	1.63
Between Rows	2	590.72	295.36	2.74
Errors	24	2589.28	107.89	
Total	38	5285.64	578.72	

Table 32d: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	8523.64	710.30	1.40
Between Rows	2	11713.72	5856.86	11.53
Errors	24	12190.94	507.96	
Total	38	32428.31	7075.12	

Table 32e: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1243.67	103.64	1.10
Between Rows	2	2801.17	1400.58	14.82
Errors	24	2268.17	94.51	
Total	38	6313.00	1598.73	

Table 32f: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Teak Plantation during 2009 - 10

Litter

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	17103.64	1425.30	1.70
Between Rows	2	20504.39	10252.19	12.23
Errors	24	20114.28	838.09	
Total	38	57722.31	12515.59	

Table 33a: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Unarable Land during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1882.67	156.89	2.54
Between Rows	6	7058.40	1176.40	19.08
Errors	72	4440.17	61.67	
Total	90	13381.24	1394.96	

Table 33b: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Unarable Land during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	256.10	21.34	1.37
Between Rows	6	2066.57	344.43	22.09
Errors	72	1122.57	15.59	
Total	90	3445.24	381.36	

Table 33c: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Unarable Land during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	3188.00	265.67	1.24
Between Rows	6	9361.95	1560.33	7.31
Errors	72	15368.33	213.45	
Total	90	27918.29	2039.44	

Table 33d: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Unarable Land during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	3819.81	318.32	1.47
Between Rows	6	8004.31	1334.05	6.15
Errors	72	15625.69	217.02	
Total	90	27449.81	1869.39	

Table 34a: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Unarable Land during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	80120.38	6676.70	2.09
Between Rows	5	35460.96	7092.19	2.22
Errors	60	191356.54	3189.28	
Total	77	306937.88	16958.17	

Table 34b: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Unarable Land during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2513.94	209.50	2.12
Between Rows	5	854.78	170.96	1.73
Errors	60	5919.22	98.65	
Total	77	9287.94	479.10	

Table 34c: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Unarable Land during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	24163.71	2013.64	1.57
Between Rows	5	16759.13	3351.83	2.61
Errors	60	76984.04	1283.07	
Total	77	117906.88	6648.53	

Table 34d: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Unarable Land during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1239.38	103.28	1.72
Between Rows	5	516.46	103.29	1.72
Errors	60	3593.04	59.88	
Total	77	5348.88	266.46	

Table 35a: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Unarable Land during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2109.64	175.80	1.51
Between Rows	2	1835.39	917.69	7.89
Errors	24	2791.94	116.33	
Total	38	6736.97	1209.83	

Table 35b: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Unarable Land during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	188.97	15.75	0.95
Between Rows	2	52.72	26.36	1.59
Errors	24	398.61	16.61	
Total	38	640.31	58.72	

Table 35c: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Unarable Land during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	29802.31	2483.53	1.65
Between Rows	2	2834.39	1417.19	0.94
Errors	24	36157.61	1506.57	
Total	38	68794.31	5407.29	

Table 35d: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Unarable Land during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2324.31	193.69	0.95
Between Rows	2	1267.06	633.53	3.10
Errors	24	4901.61	204.23	
Total	38	8492.97	1031.45	

Table 36a: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Wheat Field during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1016.99	84.75	3.98
Between Rows	6	3068.14	511.36	24.03
Errors	72	1532.43	21.28	
Total	90	5617.56	617.39	

Table 36b: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Wheat Field during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	433.43	36.12	3.34
Between Rows	6	1789.40	298.23	27.54
Errors	72	779.74	10.83	
Total	90	3002.57	345.18	

Table 36c: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Wheat Field during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	1689.18	140.76	1.96
Between Rows	6	15976.48	2662.75	37.15
Errors	72	5161.24	71.68	
Total	90	22826.89	2875.19	

Table 36d: Significance of population fluctuation of Pterygote insects as determined by ANOVA test at the site of Wheat Field during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	2039.27	169.94	3.74
Between Rows	6	10850.07	1808.35	39.75
Errors	72	3275.64	45.50	
Total	90	16164.99	2023.78	

Table 37a: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Wheat Field during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	58.11	4.84	2.40
Between Rows	5	72.61	14.52	7.20
Errors	60	121.06	2.02	
Total	77	251.78	21.38	

Table 37b: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Wheat Field during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	42.83	3.57	2.15
Between Rows	5	81.17	16.23	9.79
Errors	60	99.50	1.66	
Total	77	223.50	21.46	

Table 37c: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Wheat Field during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	549.82	45.82	5.92
Between Rows	5	325.40	65.08	8.40
Errors	60	464.76	7.75	
Total	77	1339.99	118.64	

Table 37d: Significance of population fluctuation of Apterygote insects as determined by ANOVA test at the site of Wheat Field during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	560.04	46.67	2.62
Between Rows	5	951.96	190.39	10.68
Errors	60	1069.88	17.83	
Total	77	2581.88	254.89	

Table 38a: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Wheat Field during 2008 - 09

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	484.56	40.38	8.83
Between Rows	2	42.89	21.44	4.69
Errors	24	109.78	4.57	
Total	38	637.22	66.40	

Table 38b: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Wheat Field during 2008 - 09

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	276.31	23.03	13.02
Between Rows	2	8.22	4.11	2.32
Errors	24	42.44	1.77	
Total	38	326.97	28.91	

Table 38c: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Wheat Field during 2009 - 10

Depth :- 0–5 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	45.56	3.80	3.06
Between Rows	2	28.22	14.11	11.37
Errors	24	29.78	1.24	
Total	38	103.56	19.15	

Table 38d: Significance of population fluctuation of Mites as determined by ANOVA test at the site of Wheat Field during 2009 - 10

Depth :- 5–10 cm

Source of Variation	D.F.	Sum of Square	Mean of Sum Square	F. value
Between Columns	12	87.22	7.27	2.60
Between Rows	2	105.56	52.78	18.87
Errors	24	67.11	2.80	
Total	38	259.89	62.84	

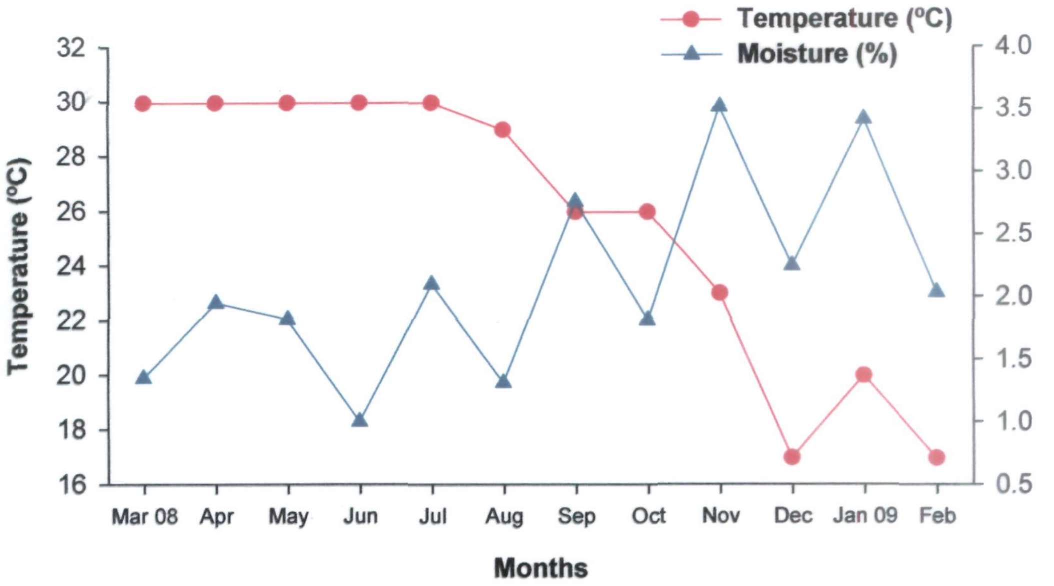


Figure 2a: Correlation between Temperature and Moisture from the site of Mango Orchards during 2008-09

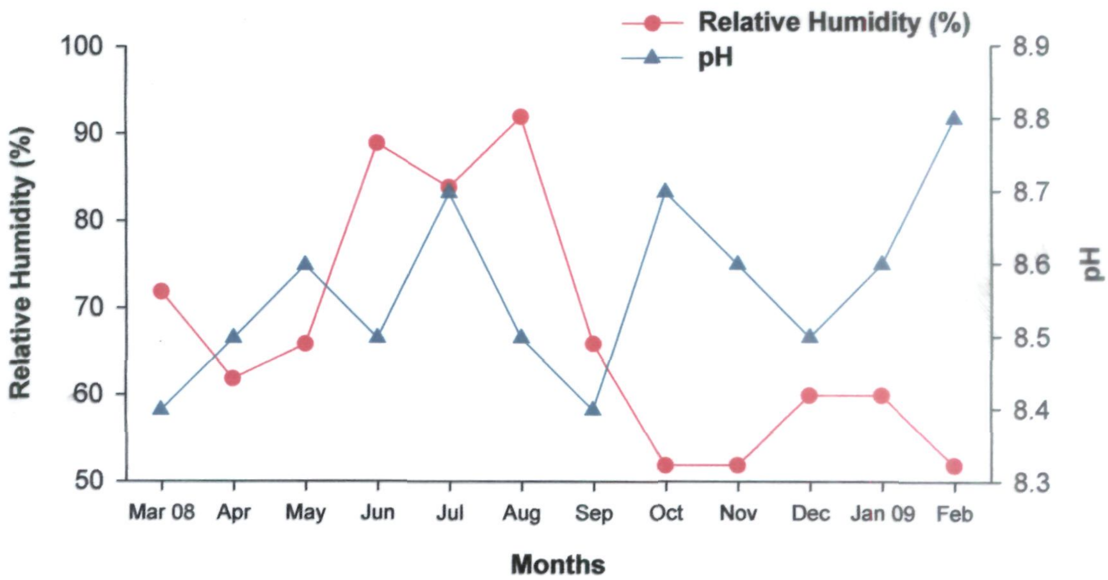


Figure 2b: Correlation between Relative Humidity and pH from the site of Mango Orchards during 2008-09

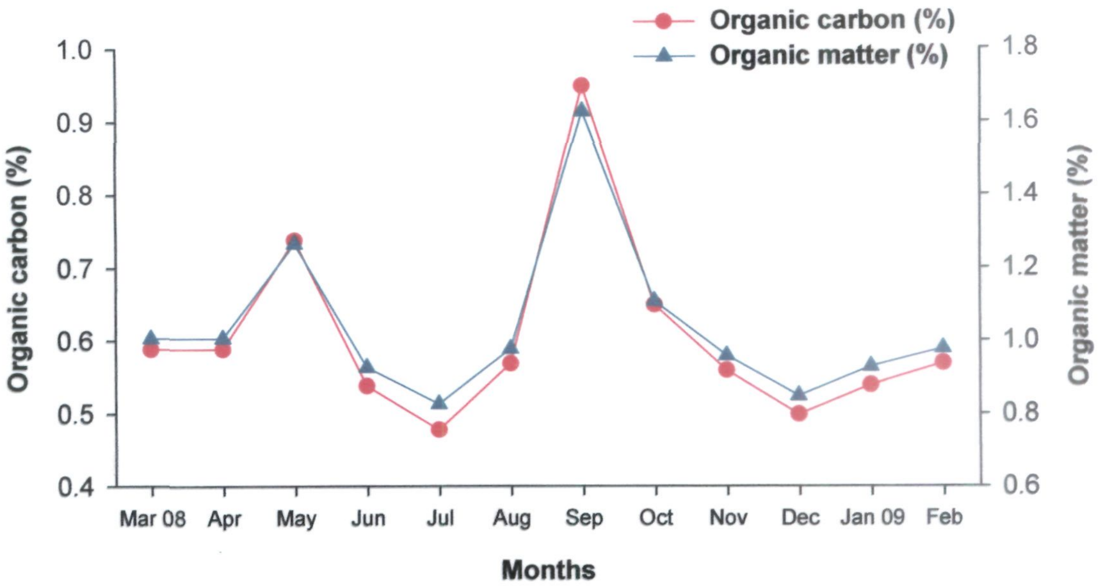


Figure 2c: Correlation between Organic Carbon and Organic Matter from the site of Mango Orchards during 2008-09

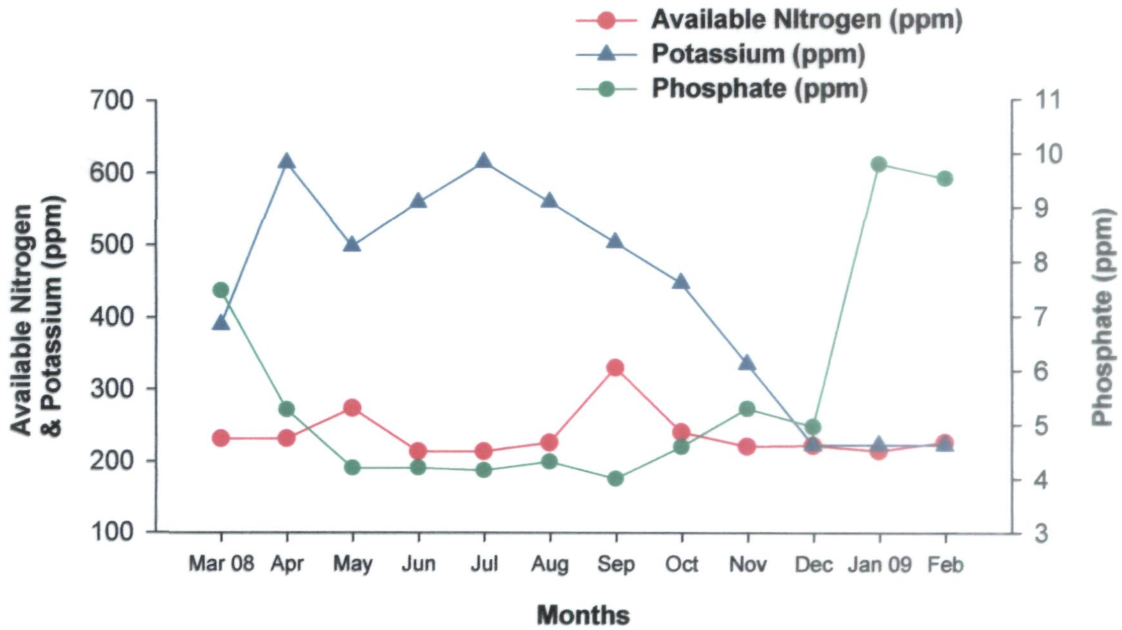


Figure 2d: Correlation between Available Nitrogen, Potassium and Phosphate from the site of Mango Orchards during 2008-09

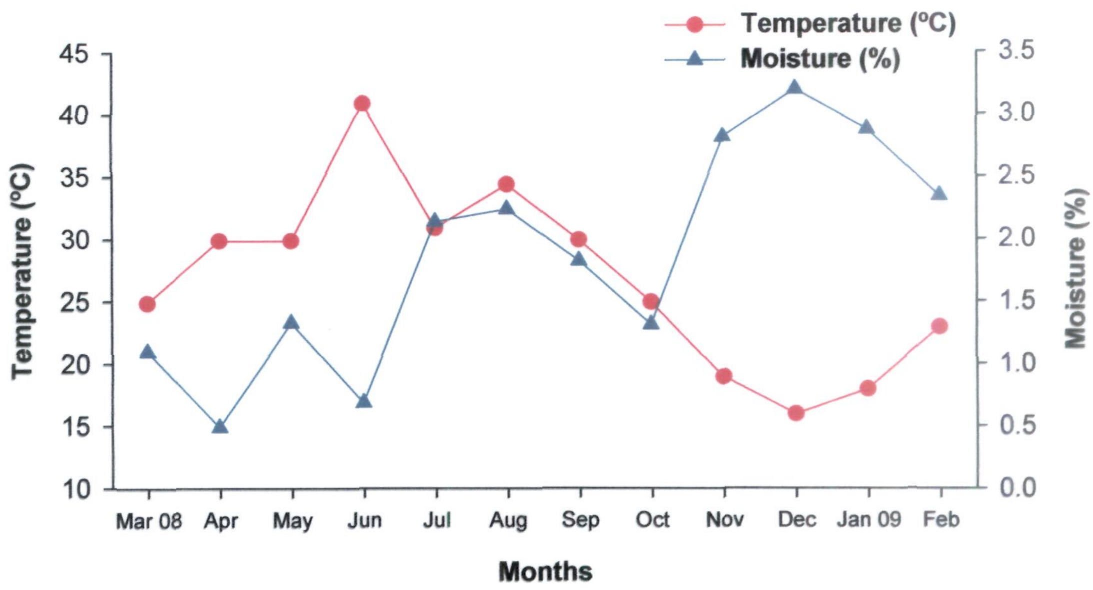


Figure 3a: Correlation between Temperature and Moisture from the site of Mango Orchards during 2009-10

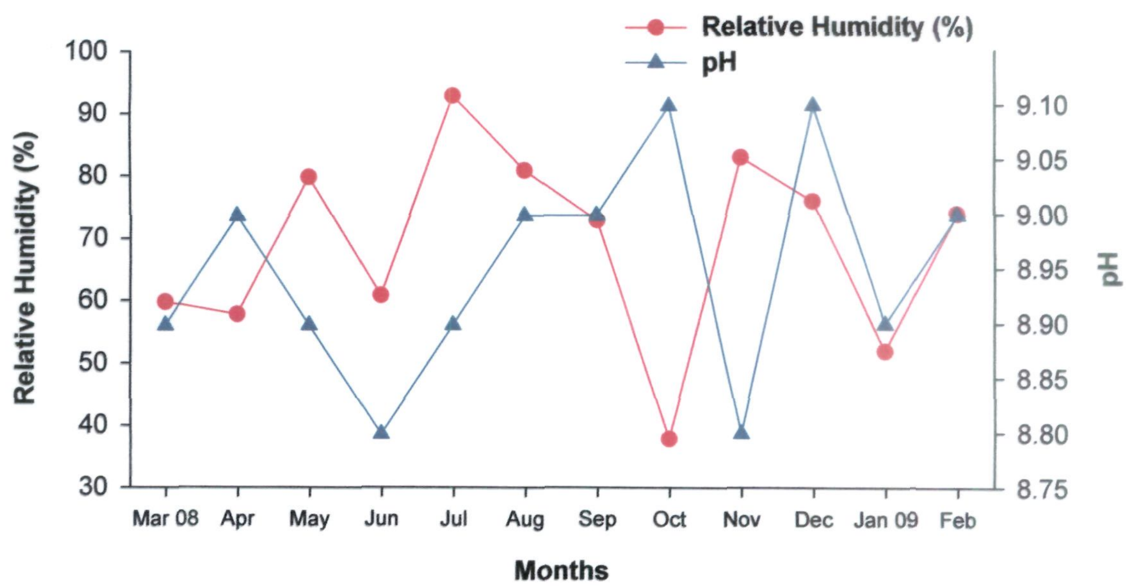


Figure 3b: Correlation between Relative Humidity and pH from the site of Mango Orchards during 2009-10

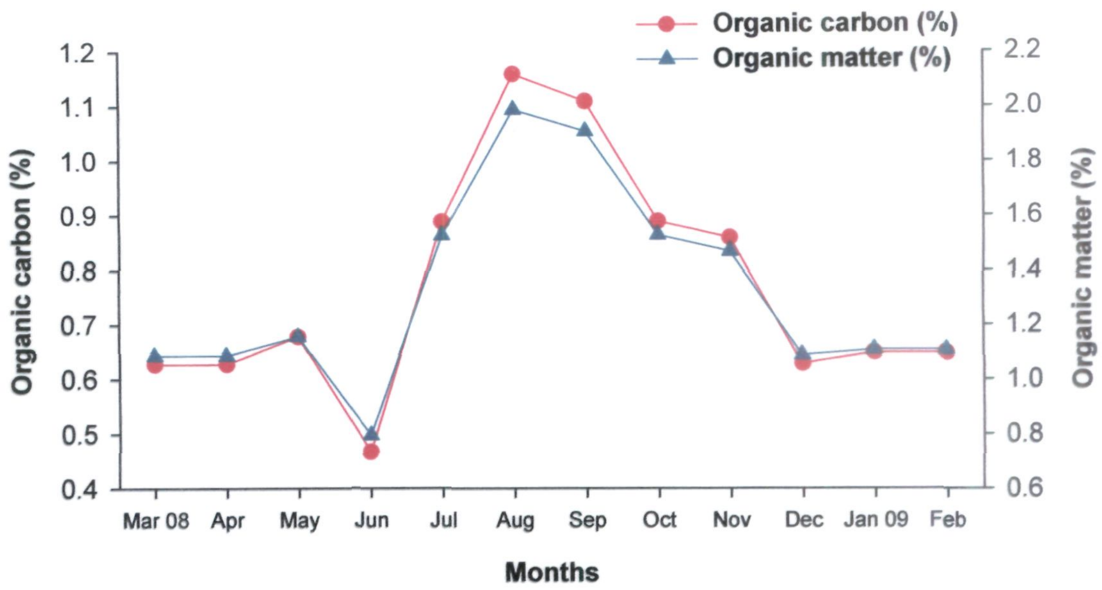


Figure 3c: Correlation between Organic Carbon and Organic Matter from the site of Mango Orchards during 2009-10

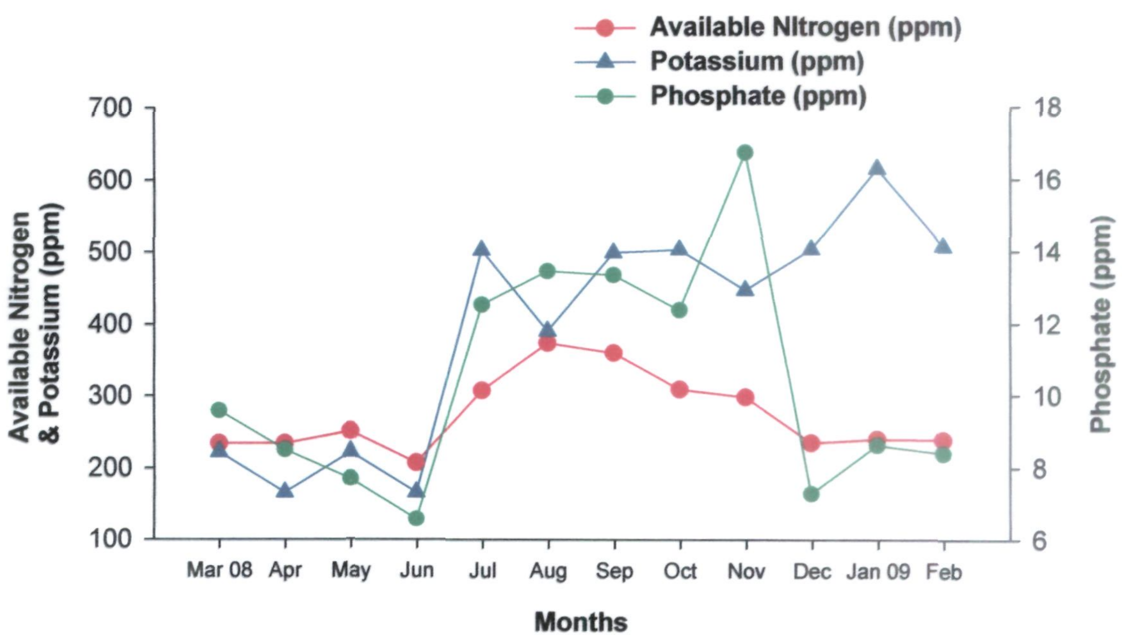


Figure 3d: Correlation between Available Nitrogen, Potassium and Phosphate from the site of Mango Orchards during 2009-10

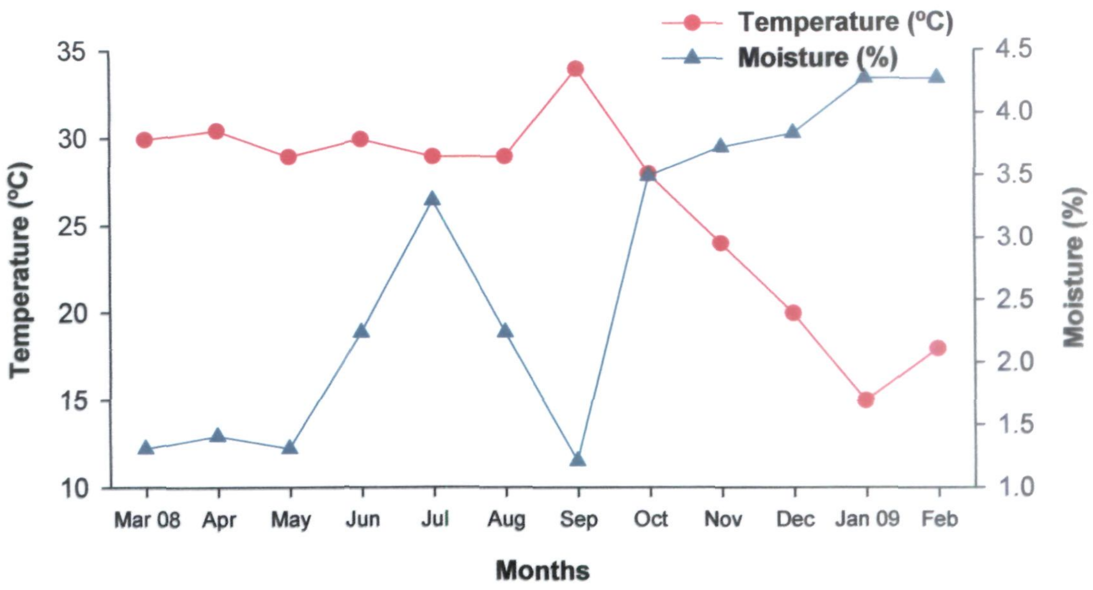


Figure 4a: Correlation between Temperature and Moisture from the site of Teak Plantation during 2008-09

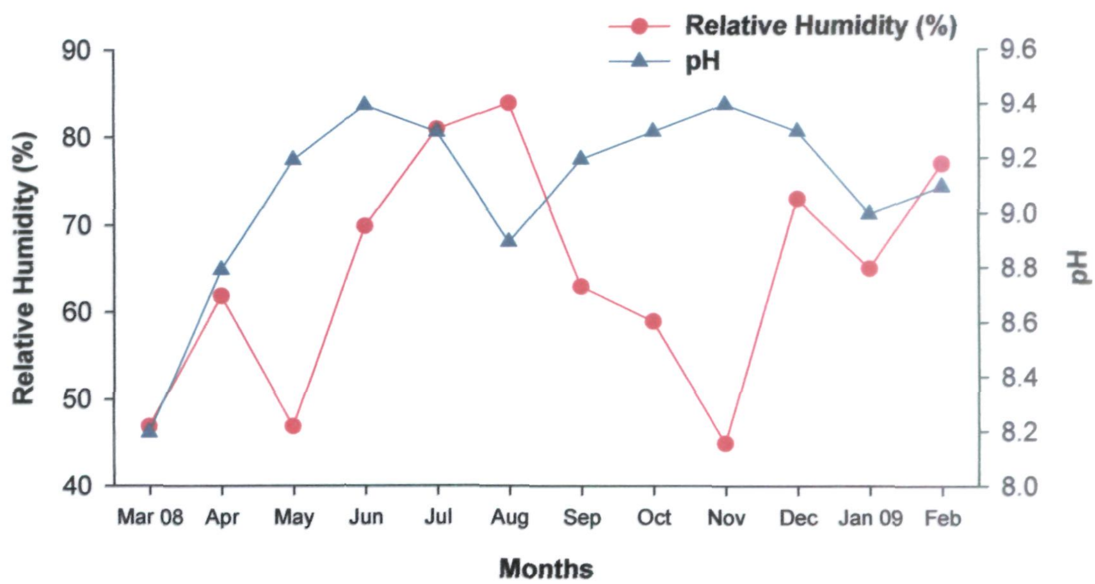


Figure 4b: Correlation between Relative Humidity and pH from the site of Teak Plantation during 2008-09

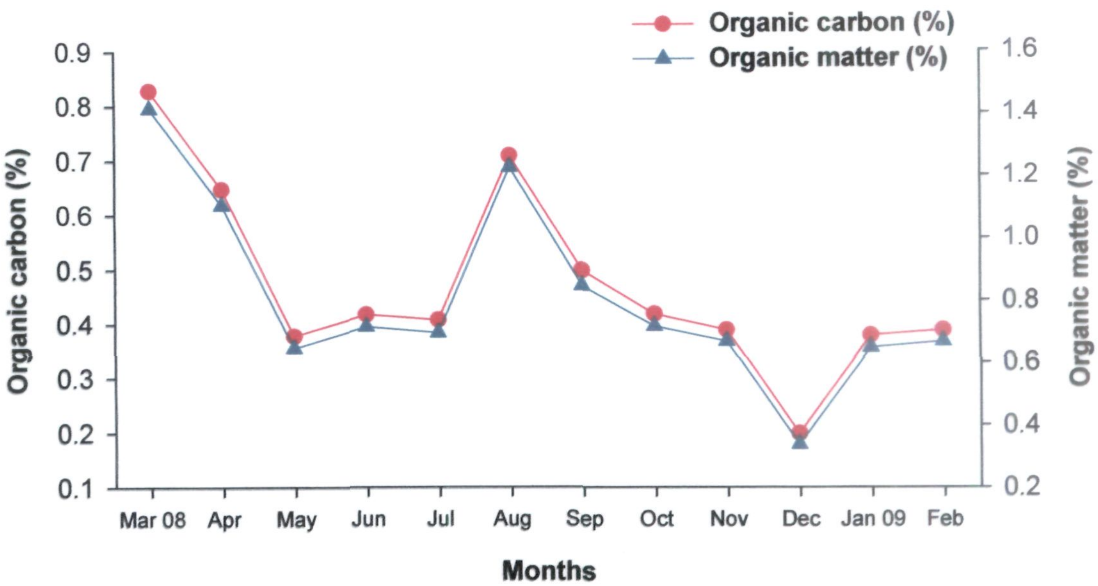


Figure 4c: Correlation between Organic Carbon and Organic Matter from the site of Teak Plantation during 2008-09

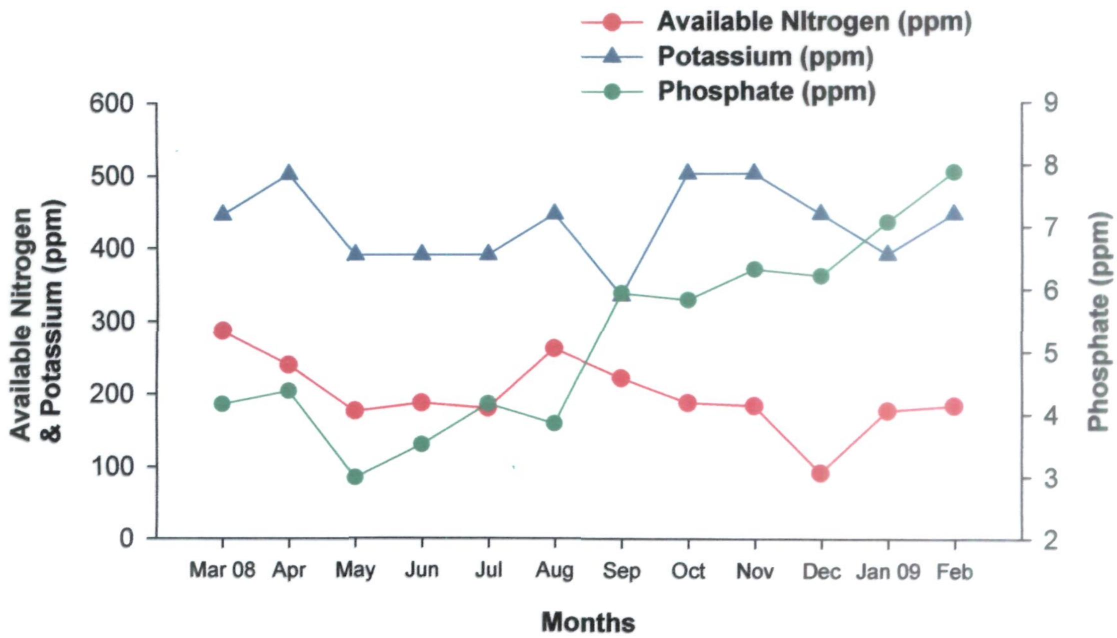


Figure 4d: Correlation between Available Nitrogen, Potassium and Phosphate from the site of Teak Plantation during 2009-10

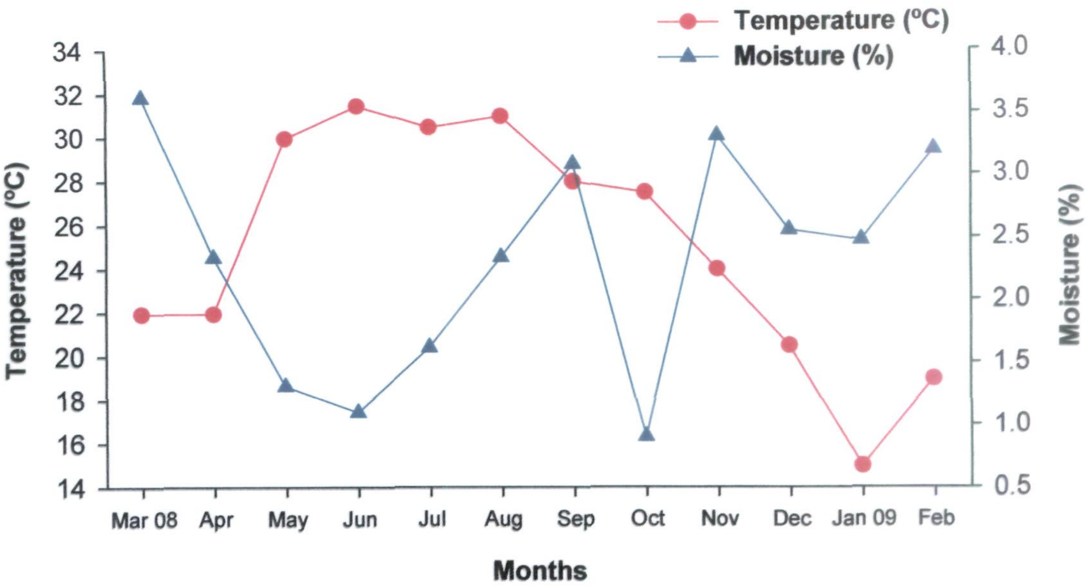


Figure 5a: Correlation between Temperature and Moisture from the site of Teak Plantation during 2009-10

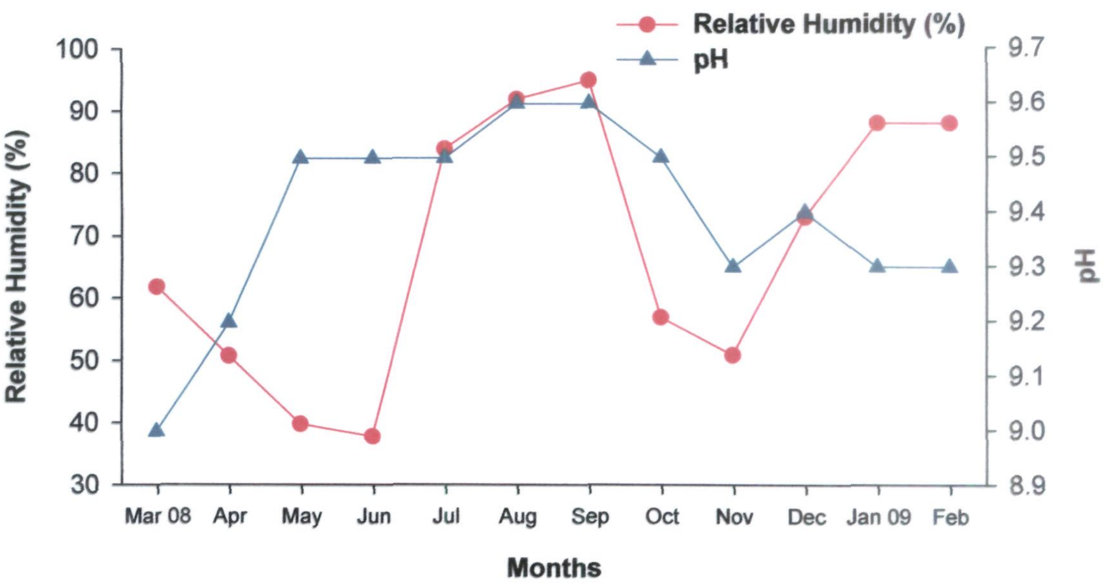


Figure 5b: Correlation between Relative Humidity and pH from the site of Teak Plantation during 2009-10

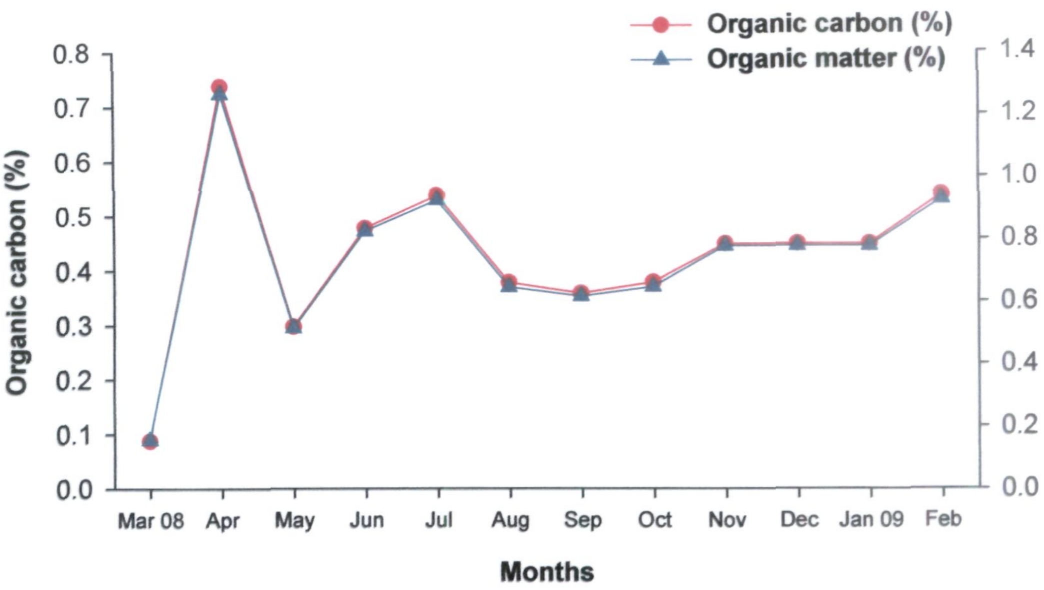


Figure 5c: Correlation between Organic Carbon and Organic Matter from the site of Teak Plantation during 2009-10

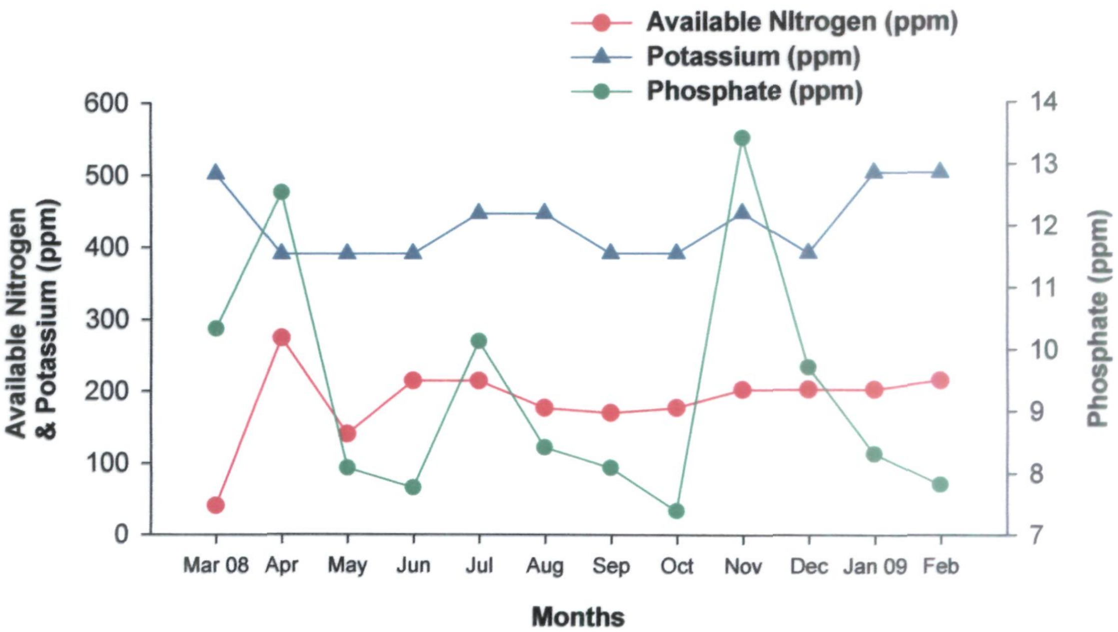


Figure5d: Correlation between Available Nitrogen, Potassium and Phosphate from the site of Teak Plantation during 2009-10

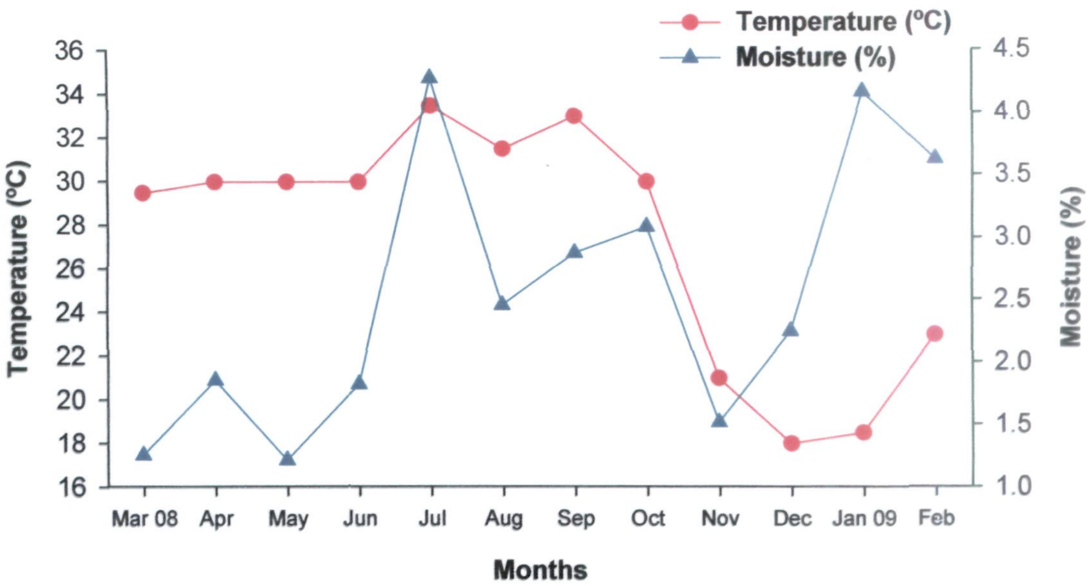


Figure 6a: Correlation between Temperature and Moisture from the site of Unarable Land during 2008-09

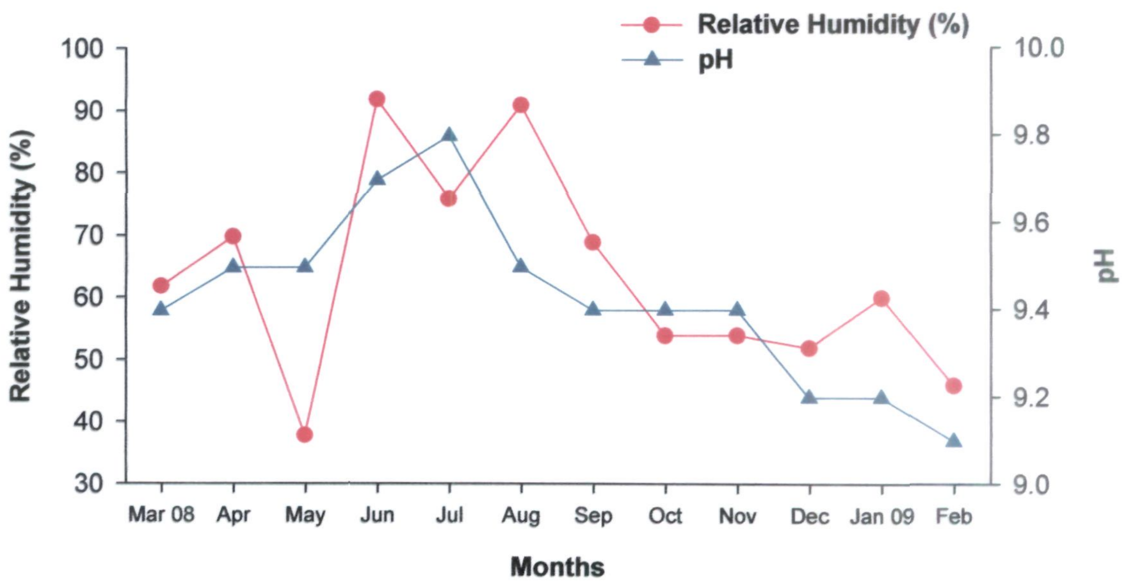


Figure 6b: Correlation between Relative Humidity and pH from the site of Unarable Land during 2008-09

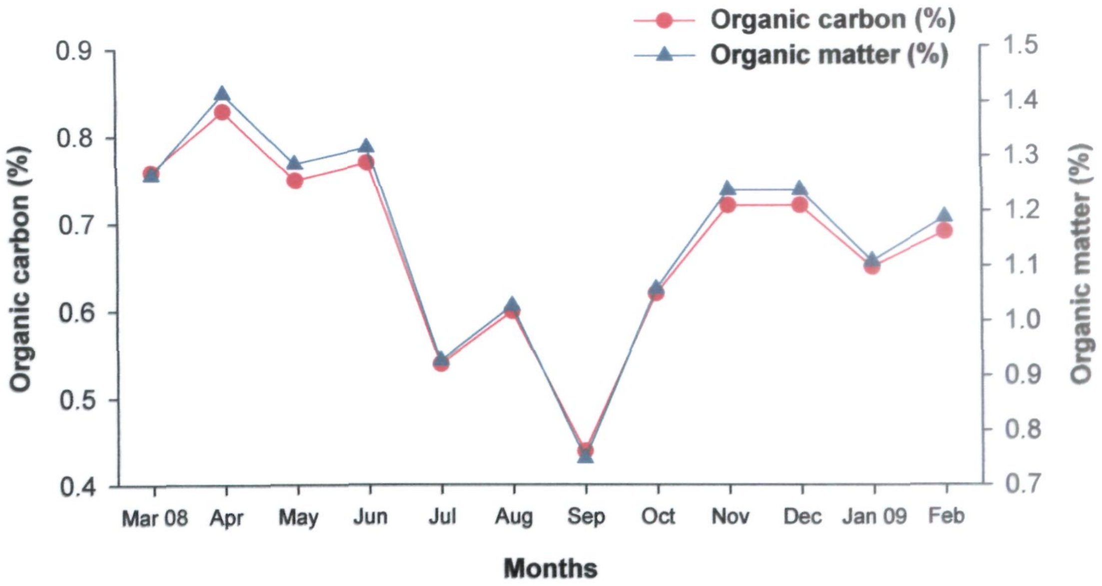


Figure 6c: Correlation between Organic Carbon and Organic Matter from the site of Unarable Land during 2008-09

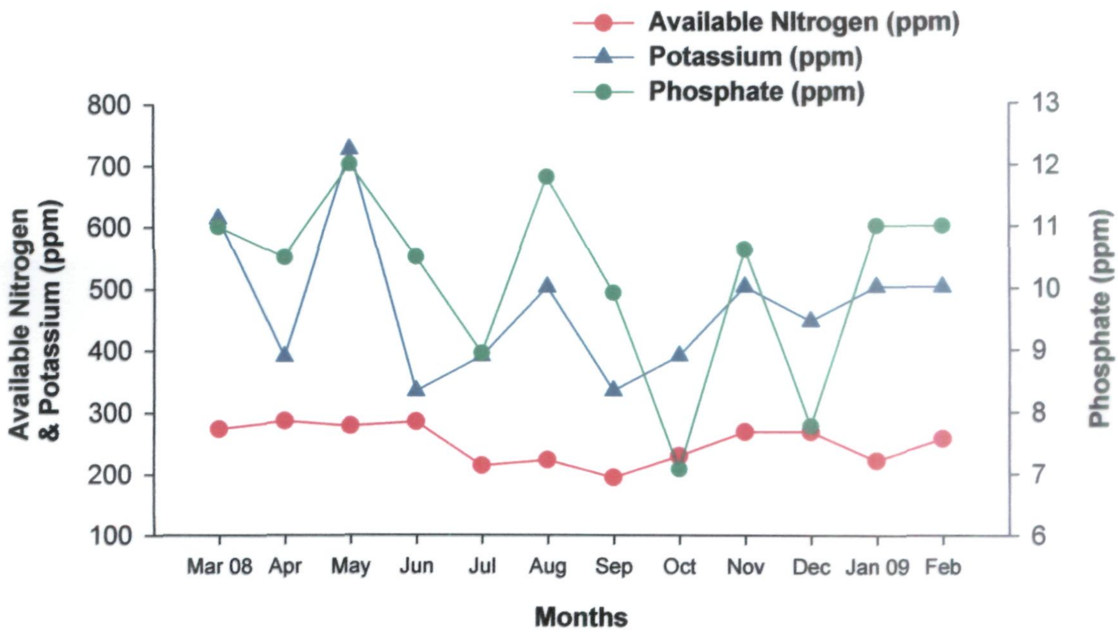


Figure 6d: Correlation between Available Nitrogen, Potassium and Phosphate from the site of Unarable Land during 2008-09

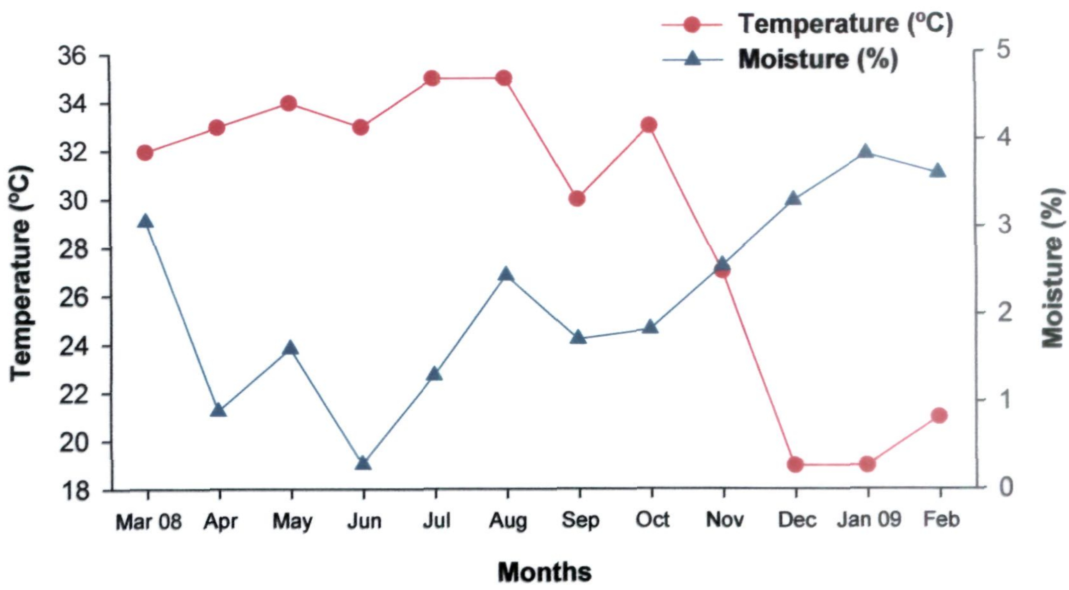


Figure 7a: Correlation between Temperature and Moisture from the site of Unarable Land during 2009-10

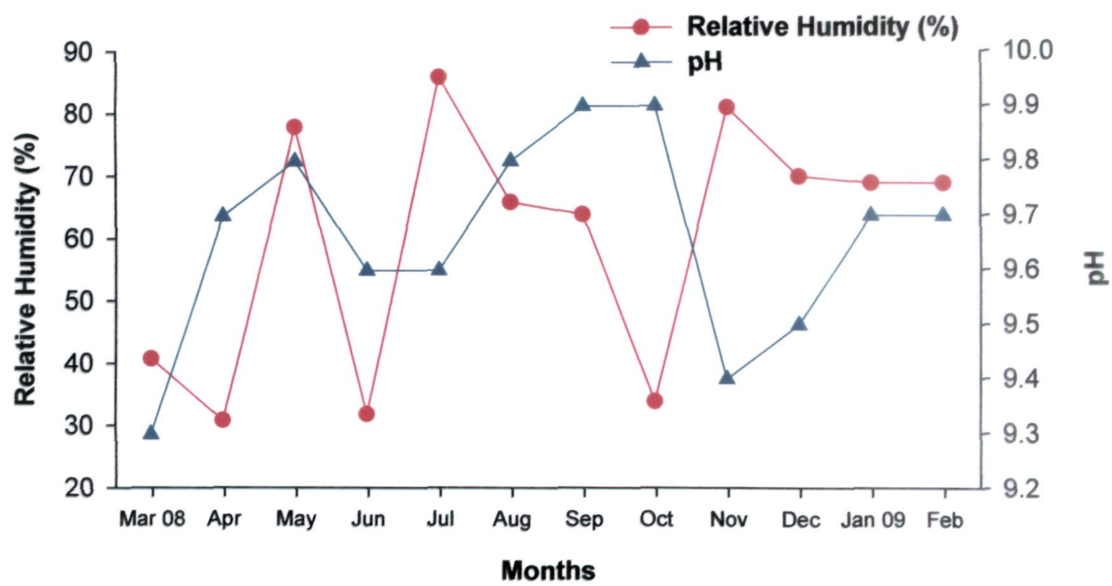


Figure 7b: Correlation between Relative Humidity and pH from the site of Unarable Land during 2009-10

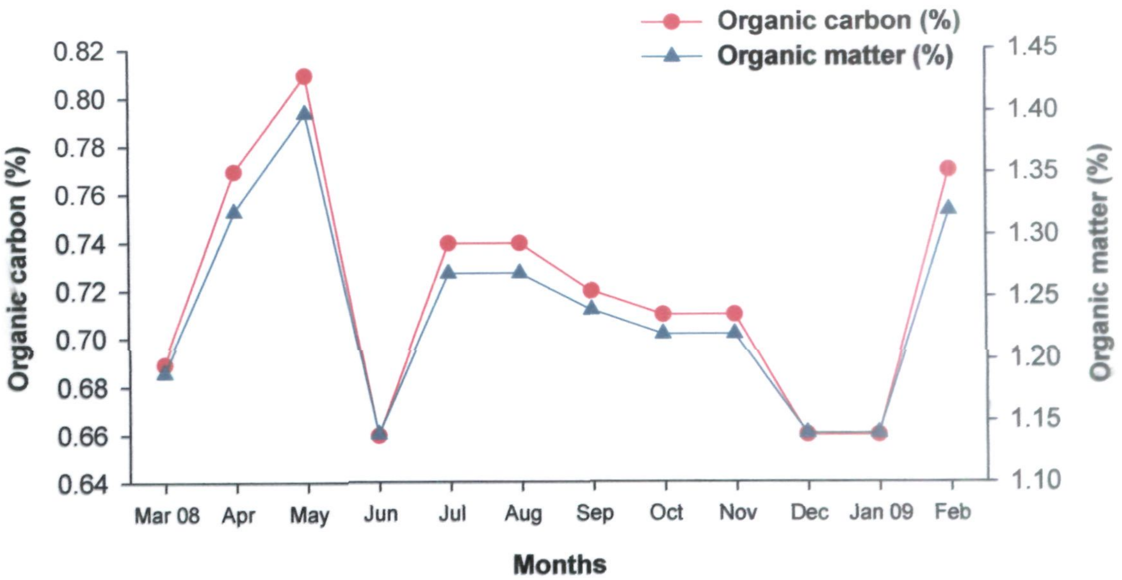


Figure 7c: Correlation between Organic Carbon and Organic Matter from the site of Unarable Land during 2009-10

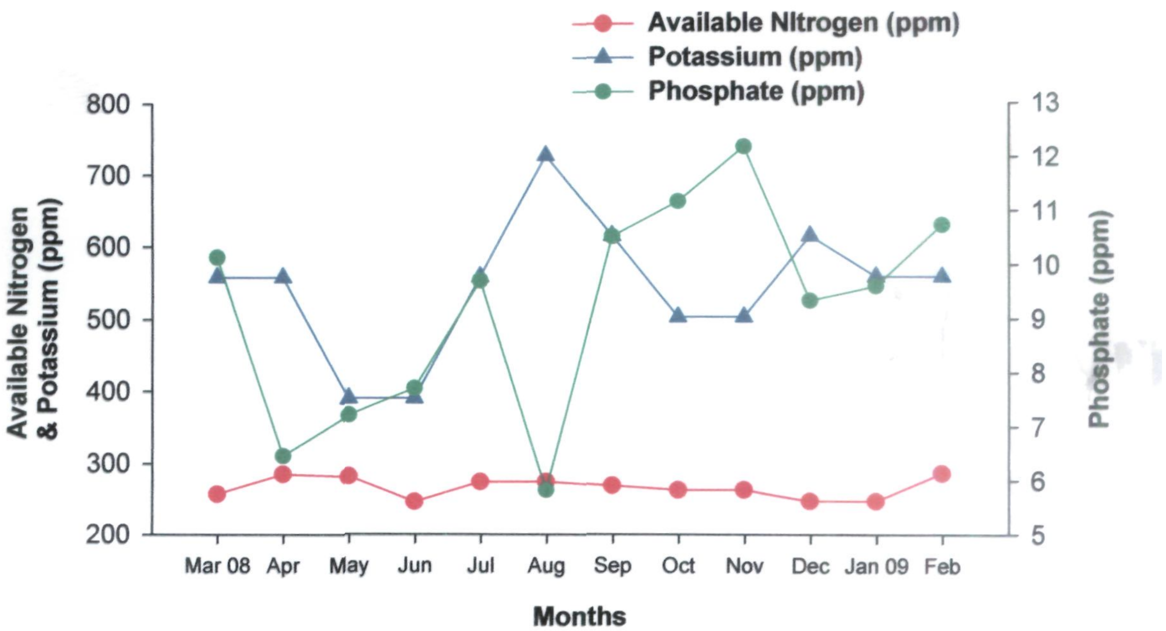


Figure 7d Correlation between Available Nitrogen, Potassium and Phosphate from the site of Unarable Land during 2009-10

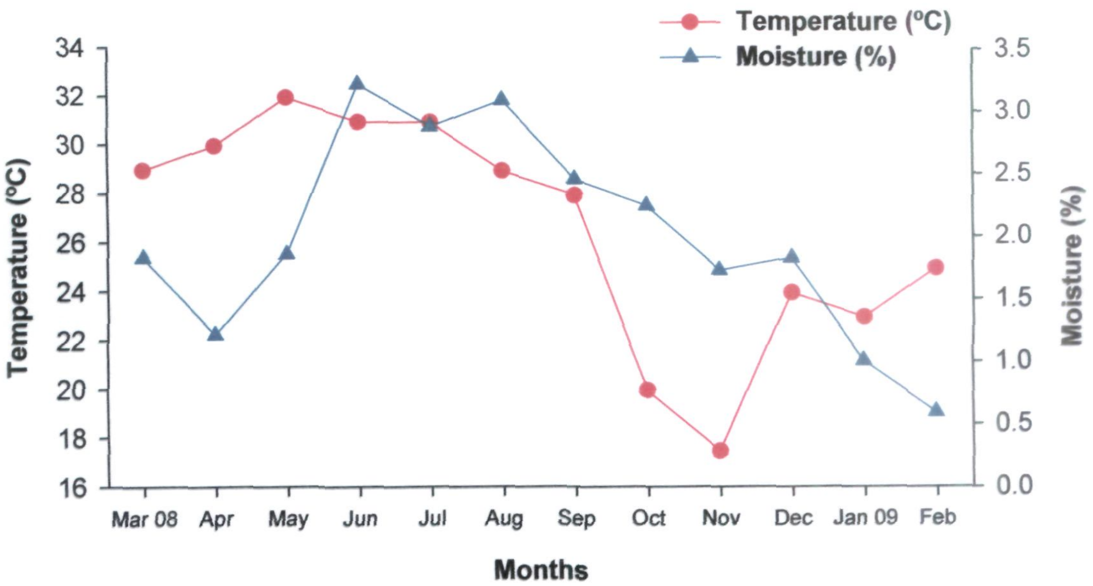


Figure 8a: Correlation between Temperature and Moisture from the site of Wheat Field during 2008-09

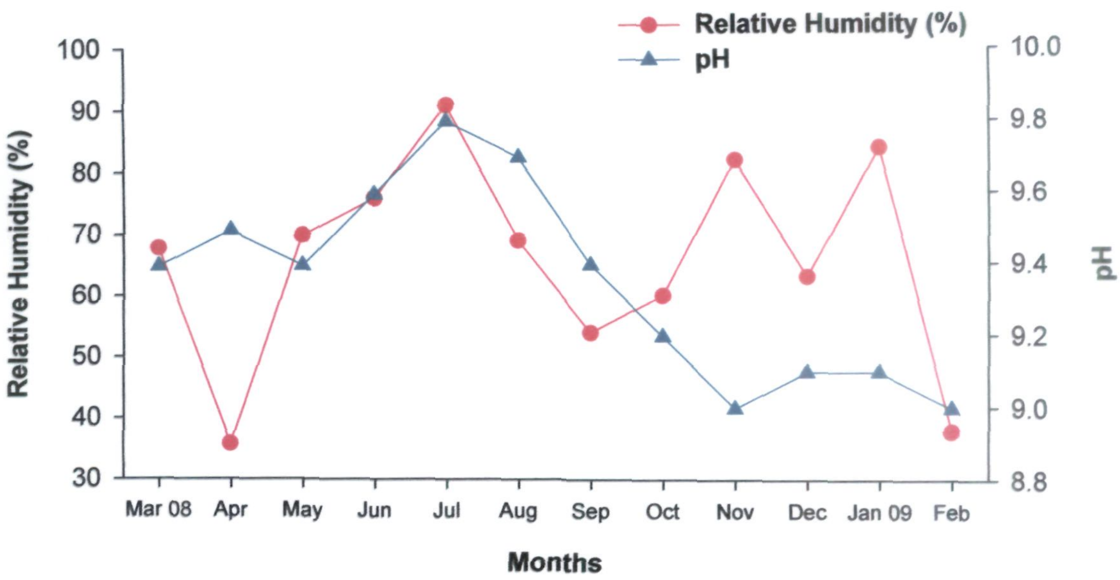


Figure 8b: Correlation between Relative Humidity and pH from the site of Wheat Field during 2008-09

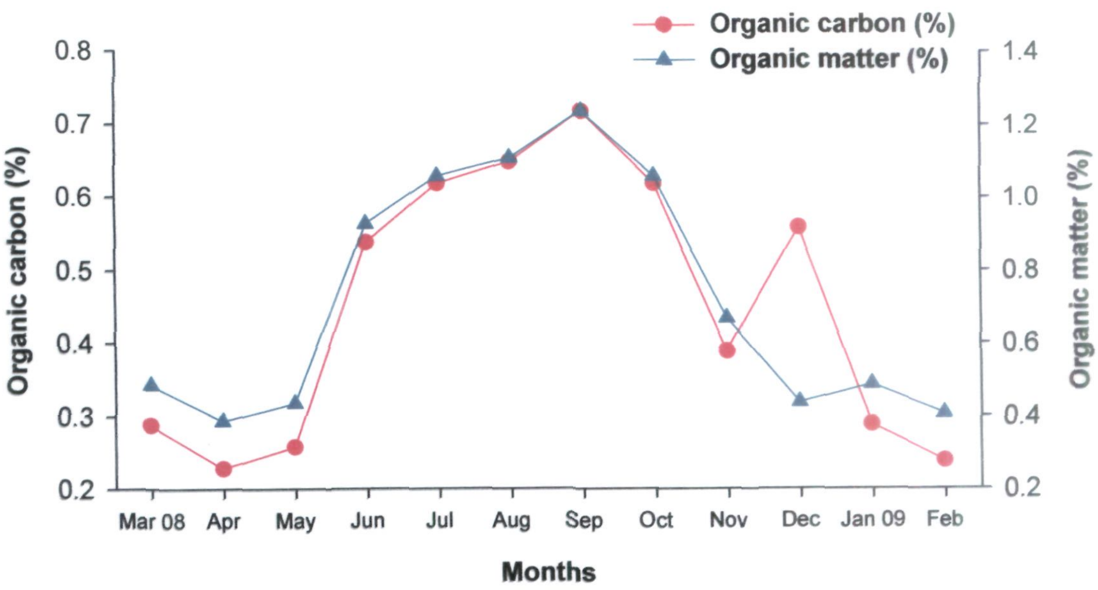


Figure 8c: Correlation between Organic Carbon and Organic Matter from the site of Wheat Field during 2008-09

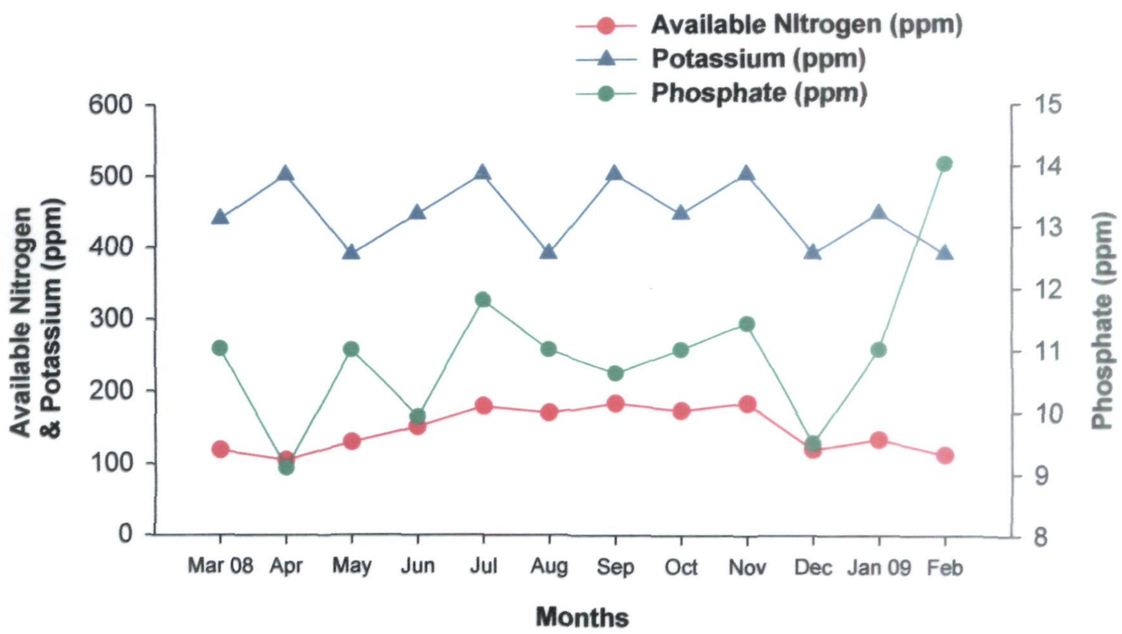


Figure 8d: Correlation between Available Nitrogen, Potassium and Phosphate from the site of Wheat Field during 2008-09

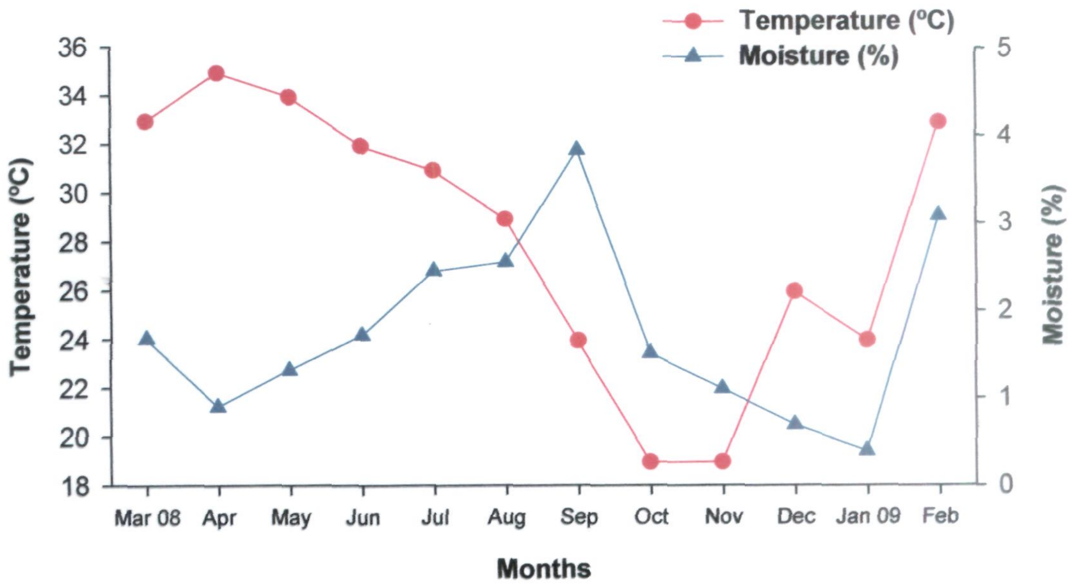


Figure 9a: Correlation between Temperature and Moisture from the site of Wheat Field during 2009-10

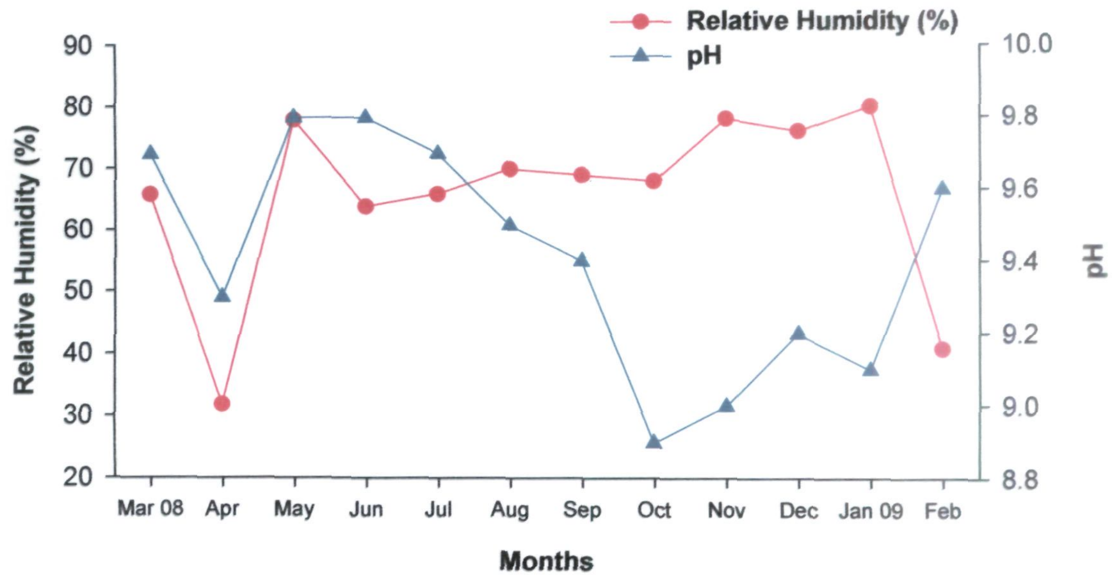


Figure 9b: Correlation between Relative Humidity and pH from the site of Wheat Field during 2009-10

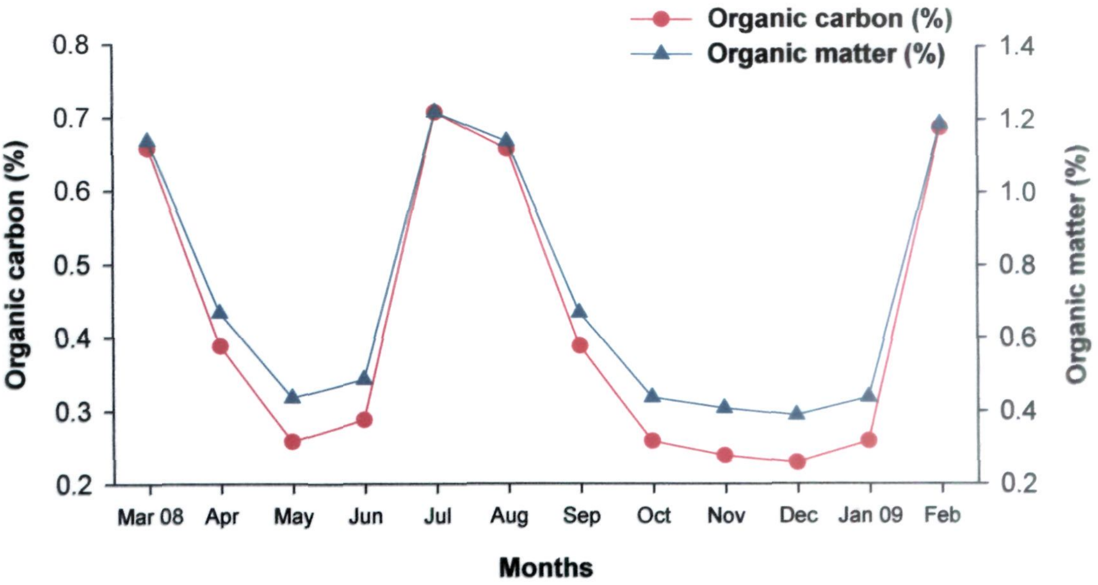


Figure 9c: Correlation between Organic Carbon and Organic Matter from the site of Wheat Field during 2009-10

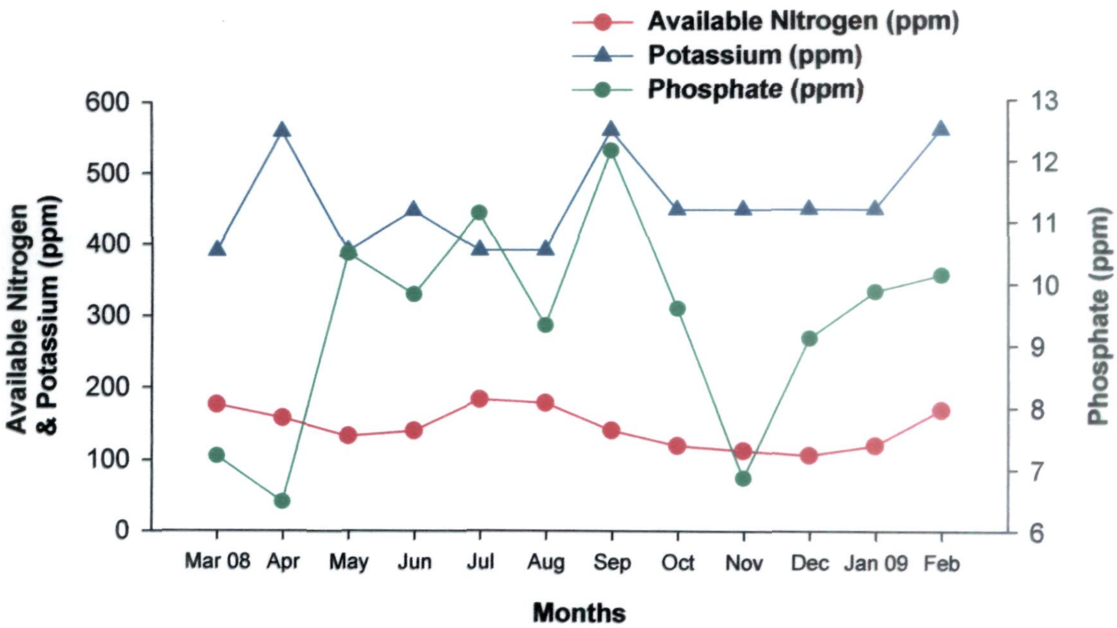
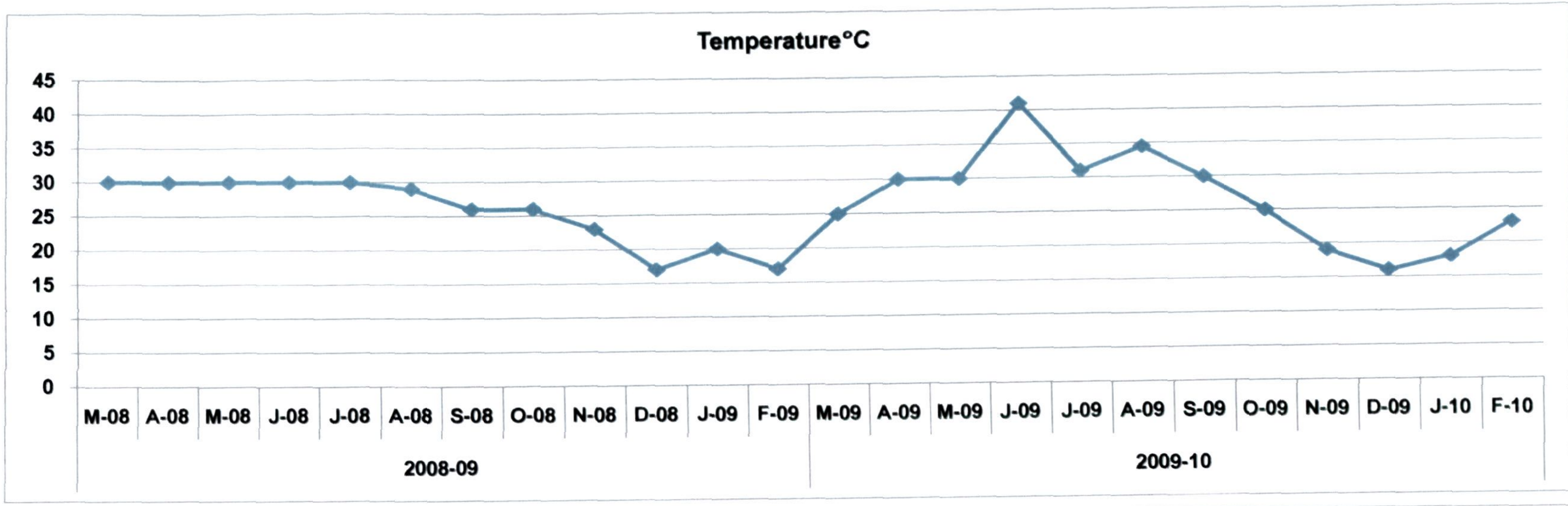


Figure 9d: Correlation between Available Nitrogen, Potassium and Phosphate from the site of Wheat Field during 2009-10



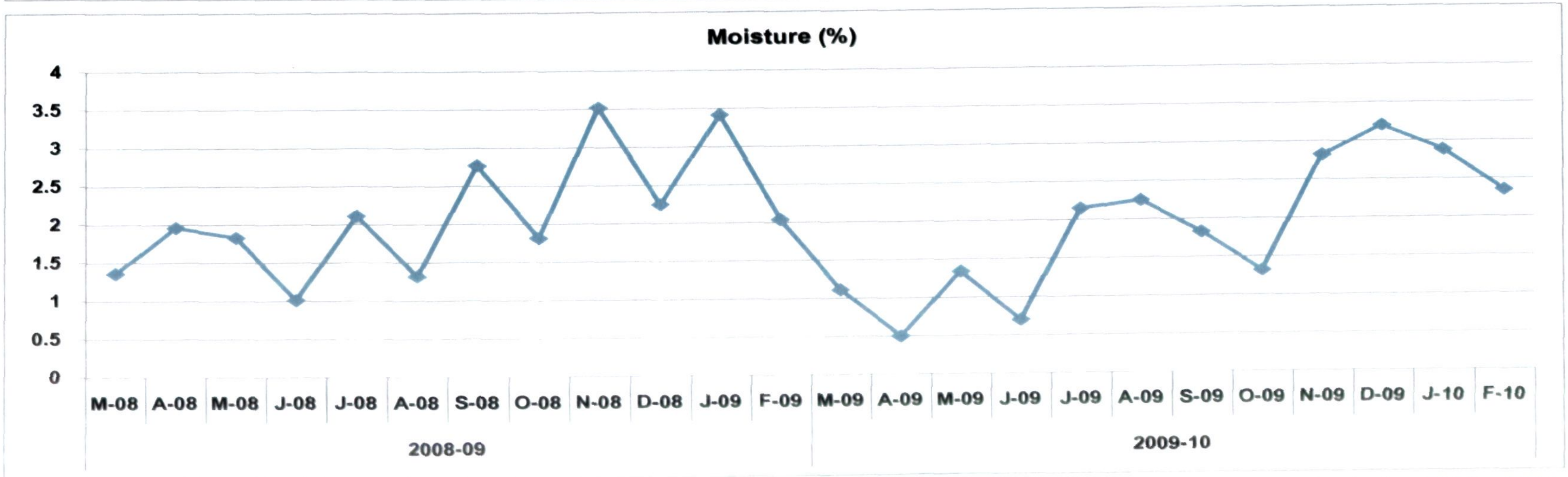
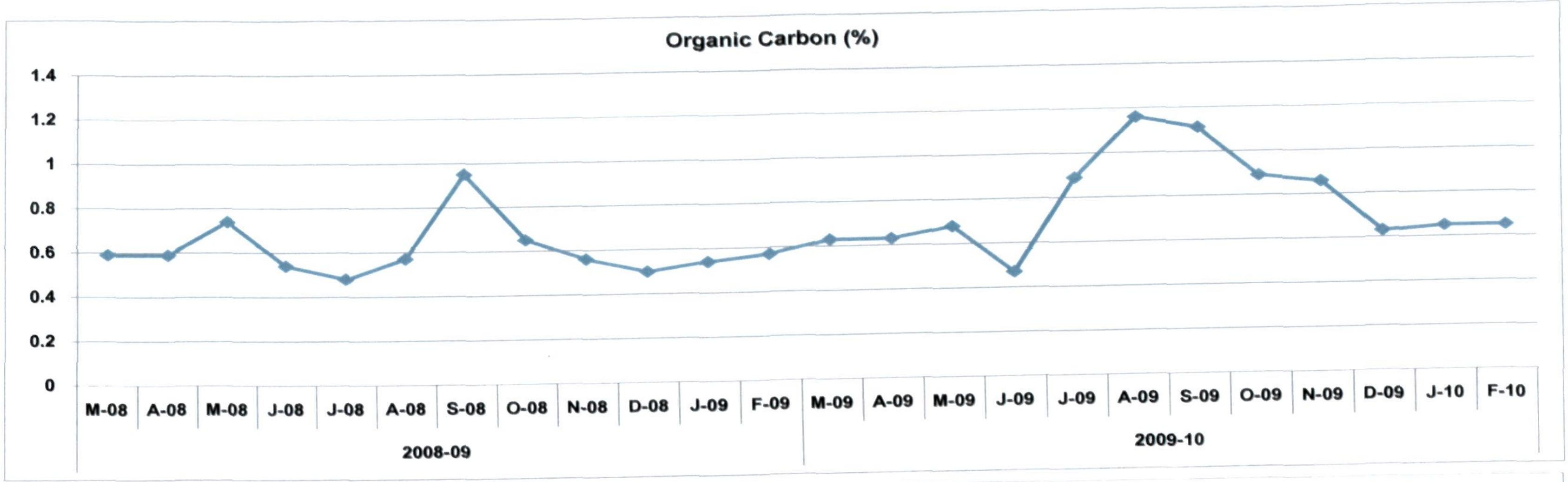


Figure 10a (i): Fluctuation of the edaphic factors (Temperature and Moisture) from the site of Mango Orchards during 2008 – 2010

Figure 10a (ii): Fluctuation of the edaphic factors (Relative Humidity and pH) from the site of Mango Orchards during 2008 – 2010



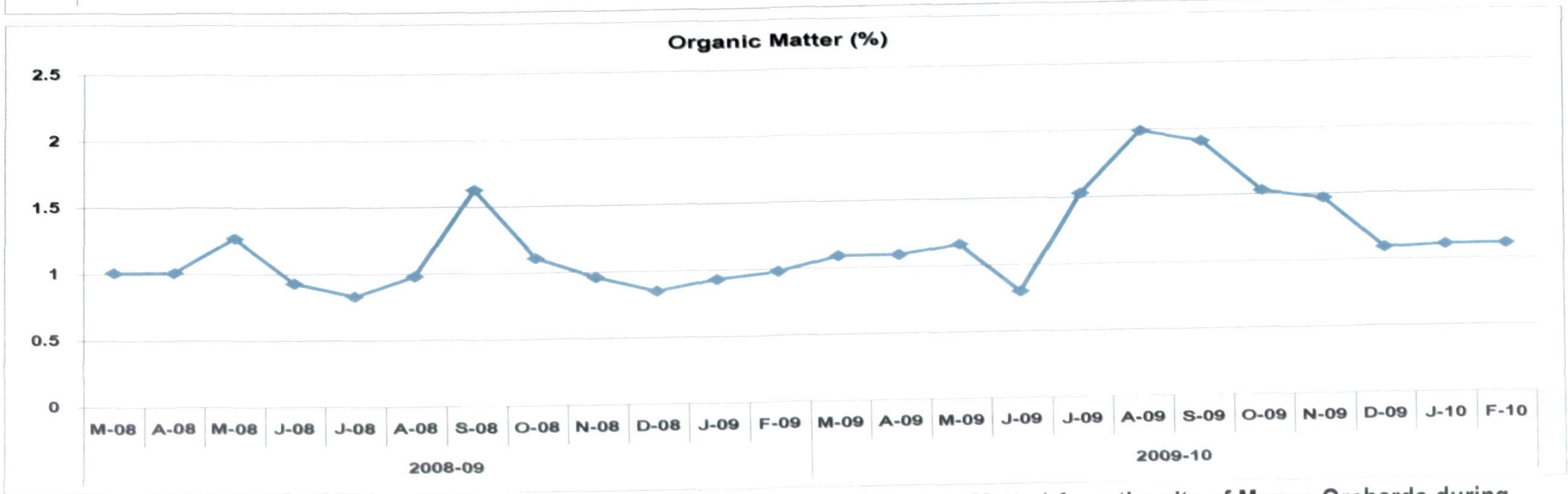


Figure 10a (iii): Fluctuation of the edaphic factors (Organic Carbon and Organic Matter) from the site of Mango Orchards during 2008 – 2010

Figure 10a (iv): Fluctuation of the edaphic factors (Available Nitrogen and Potassium) from the site of Mango Orchards during 2008 – 2010

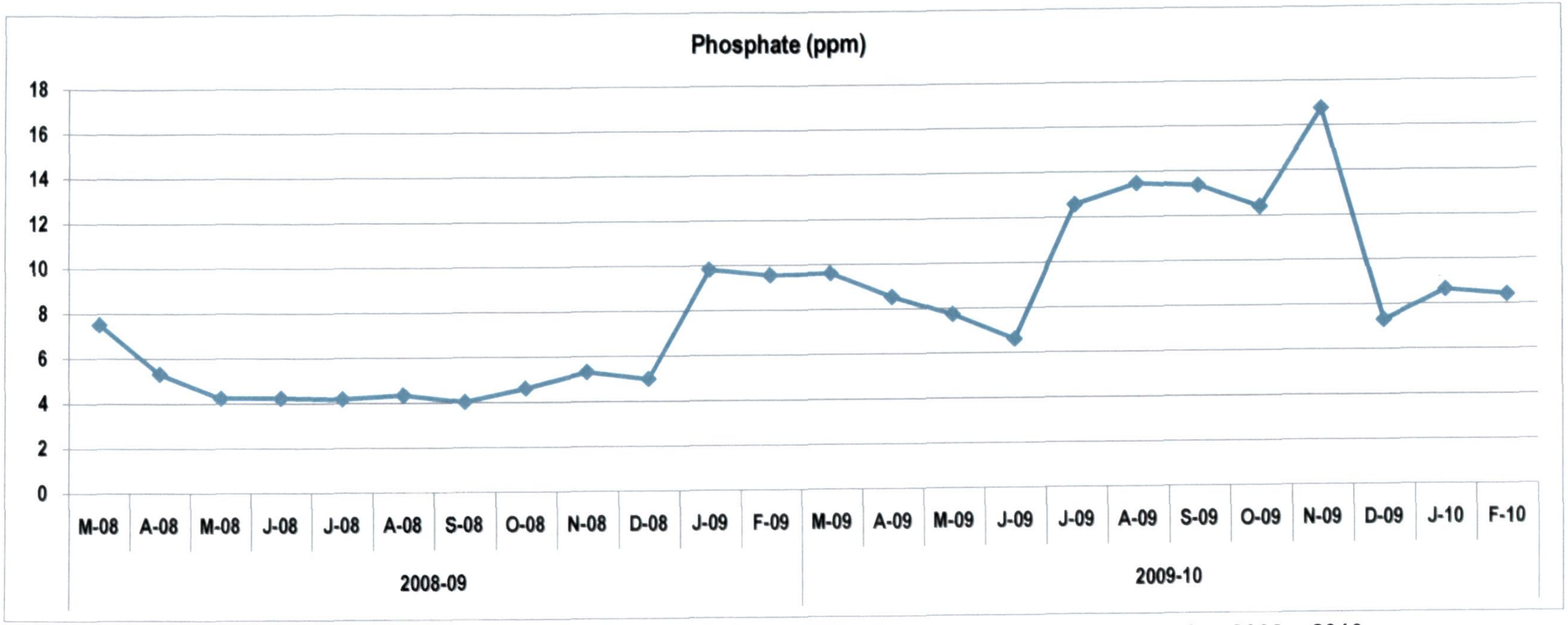
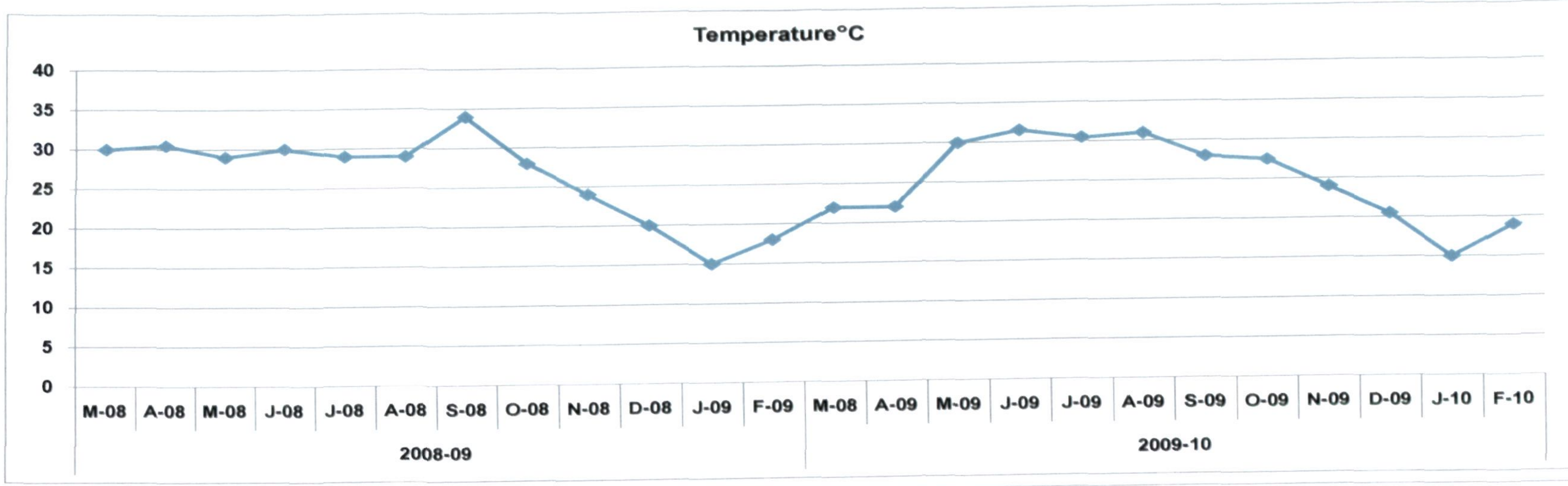


Figure 10a (v): Fluctuation of the edaphic factor (Phosphate) from the site of Mango Orchards during 2008 – 2010.



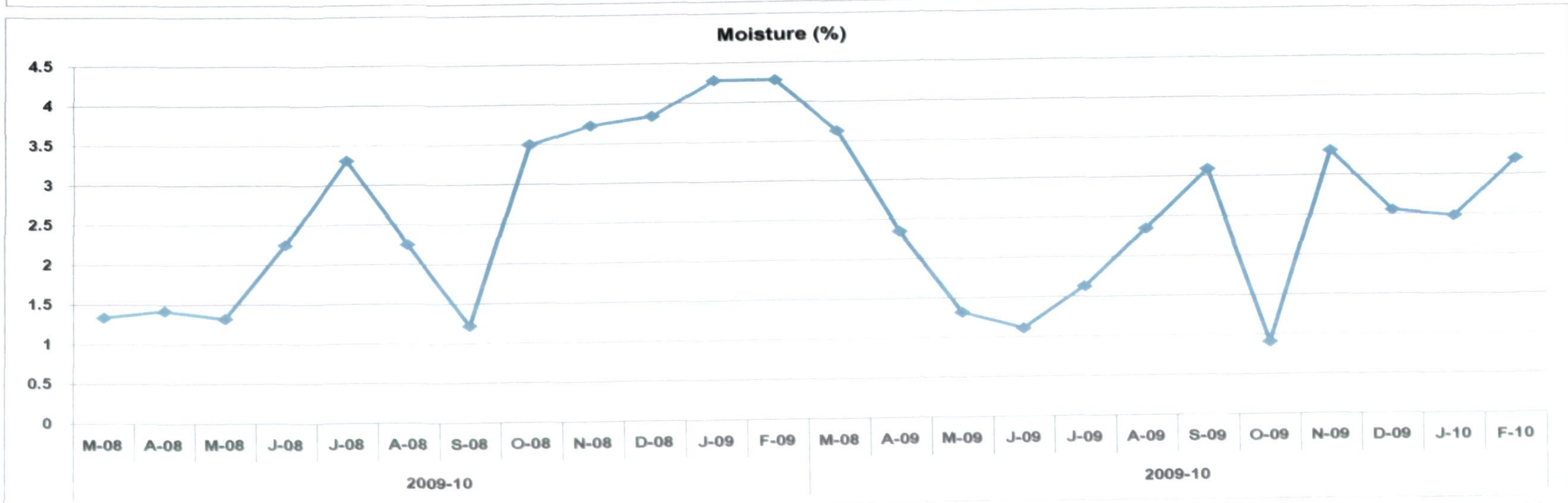


Figure 10b (i): Fluctuation of the edaphic factors (Temperature and Moisture) from the site of Teak Plantation during 2008 – 2010

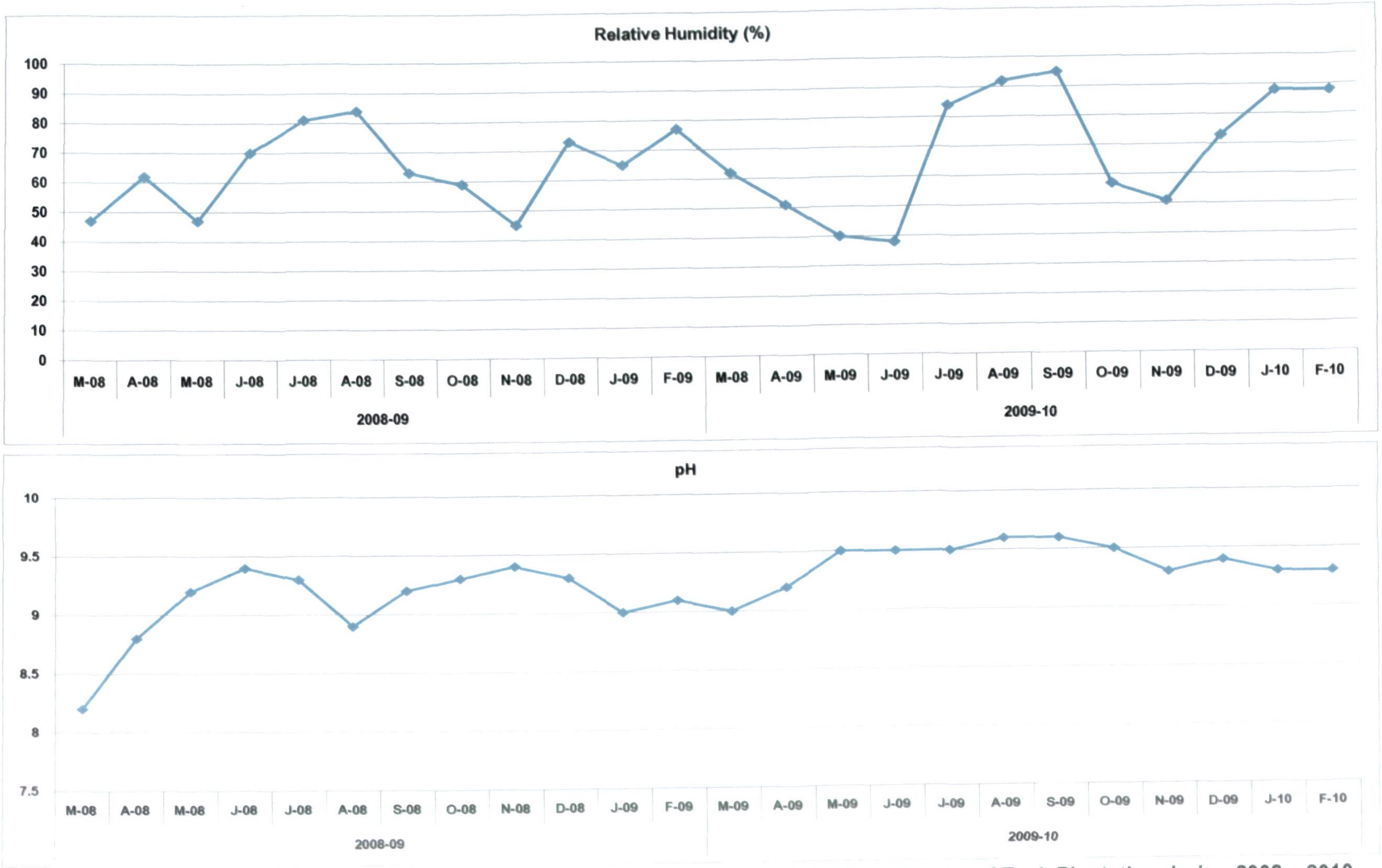


Figure 10b (ii): Fluctuation of the edaphic factors (Relative Humidity and pH) from the site of Teak Plantation during 2008 – 2010

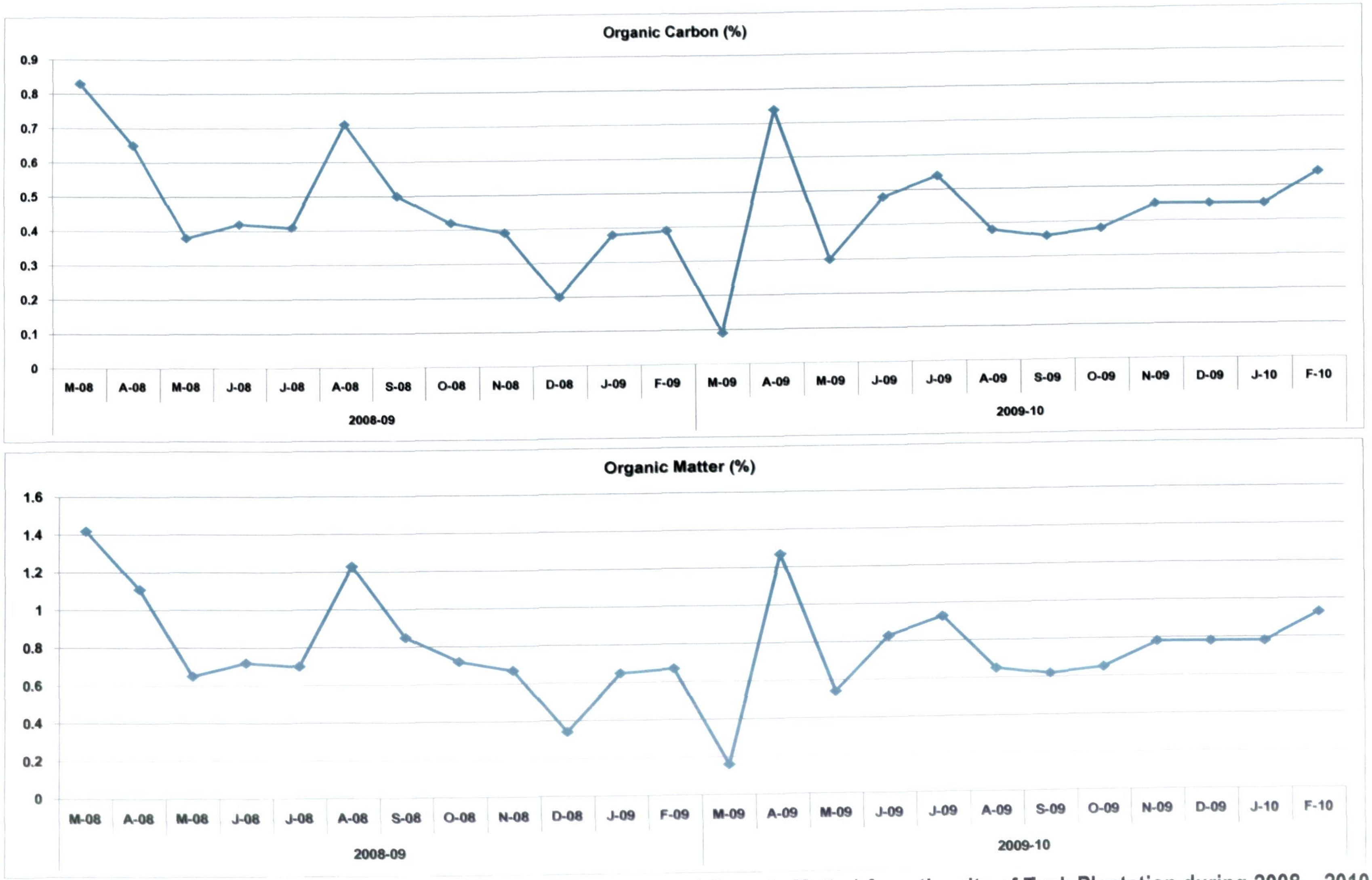
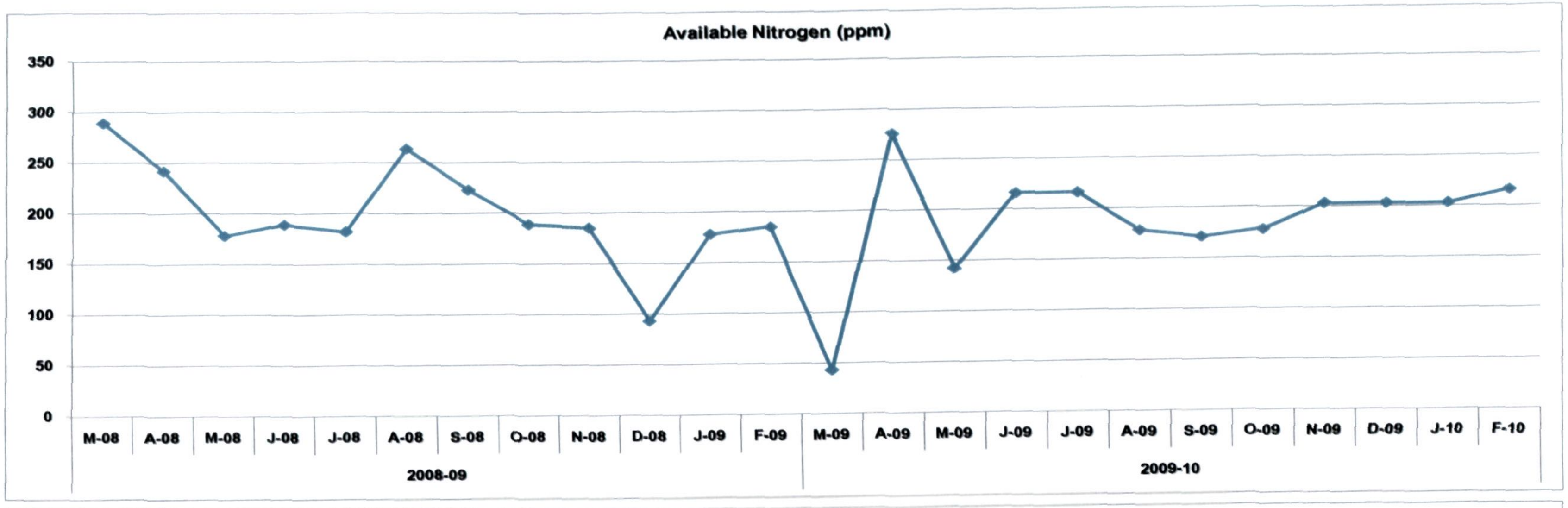


Figure 10b (iii): Fluctuation of the edaphic factors (Organic Carbon and Organic Matter) from the site of Teak Plantation during 2008 – 2010



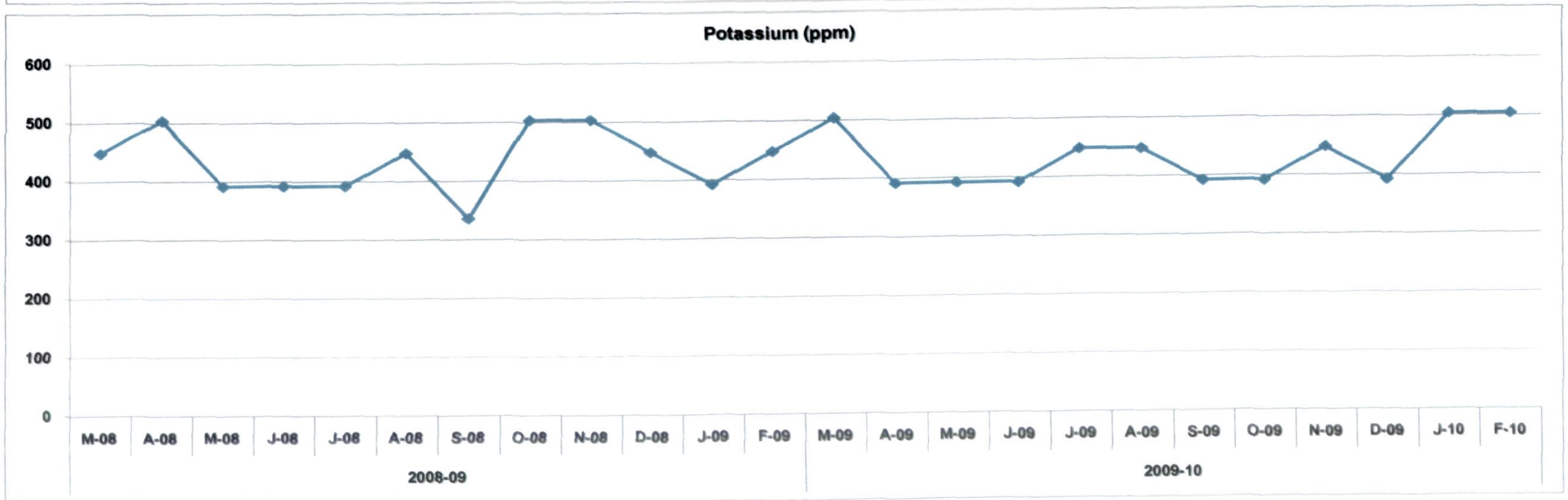


Figure 10b (iv): Fluctuation of the edaphic factors (Available Nitrogen and Potassium) from the site of Teak Plantation during 2008 – 2010

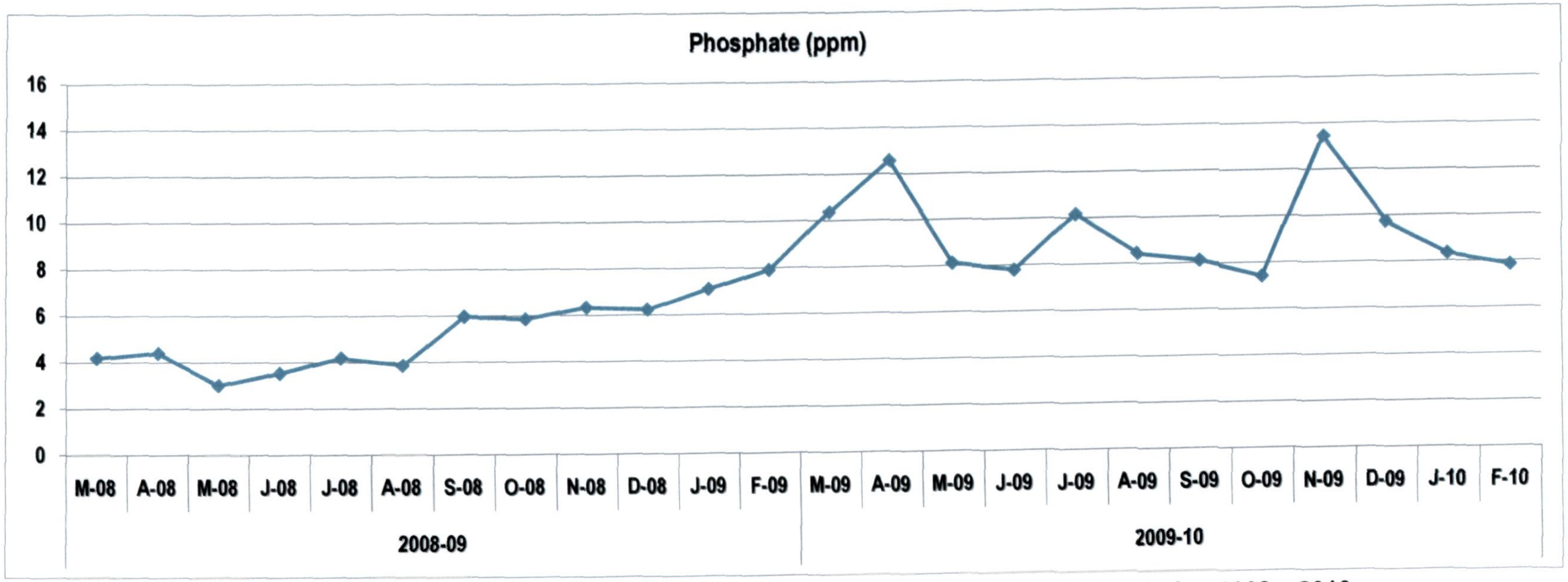


Figure 10b (v): Fluctuation of the edaphic factor (Phosphate) from the site of Teak Plantation during 2008 – 2010

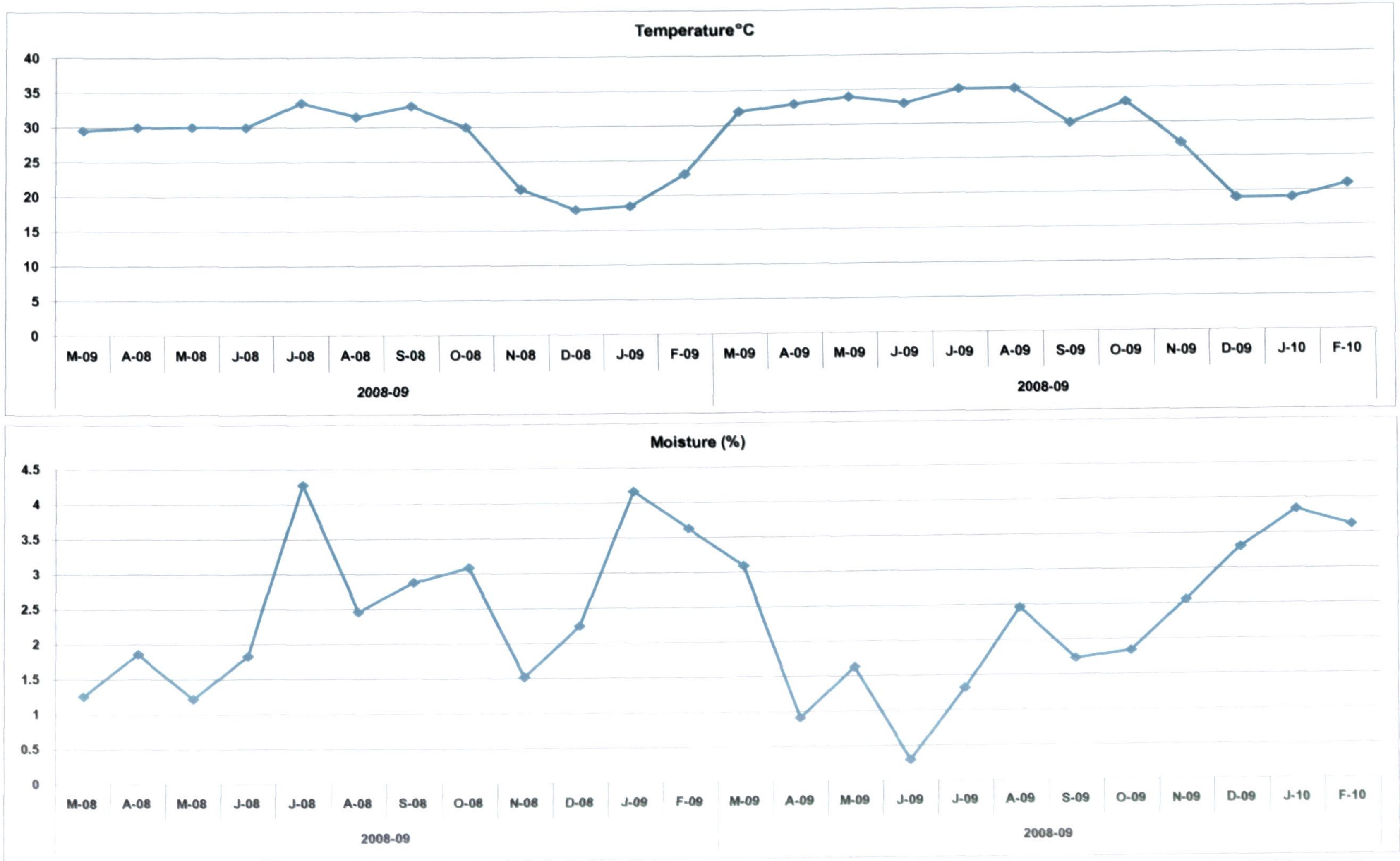
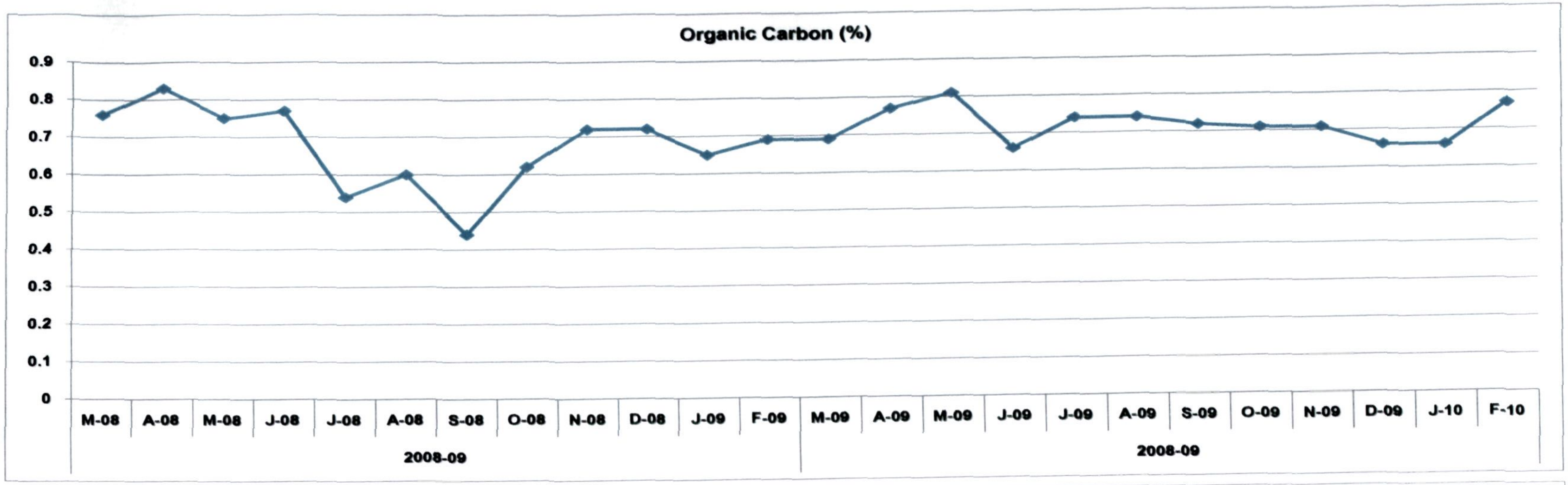


Figure 10c (i): Fluctuation of the edaphic factors (Temperature and Moisture) from the site of Unarable Land during 2008 – 2010

Figure 10c (ii): Fluctuation of the edaphic factors (Relative Humidity and pH) from the site of Unarable Land during 2008 – 2010



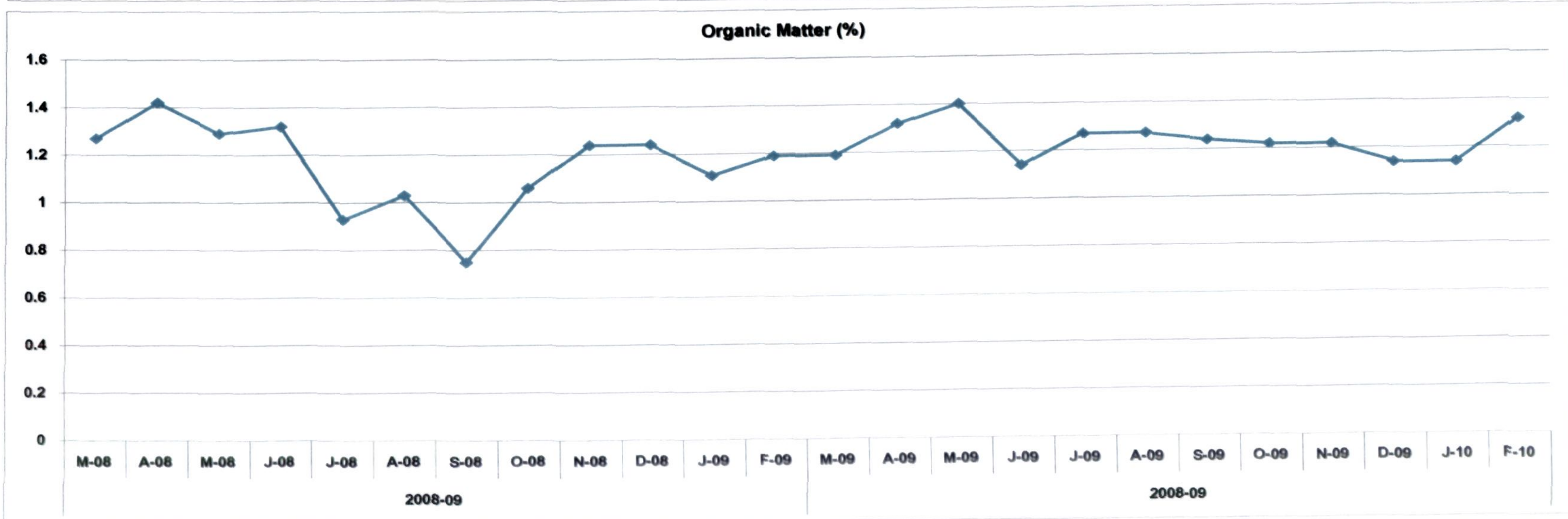
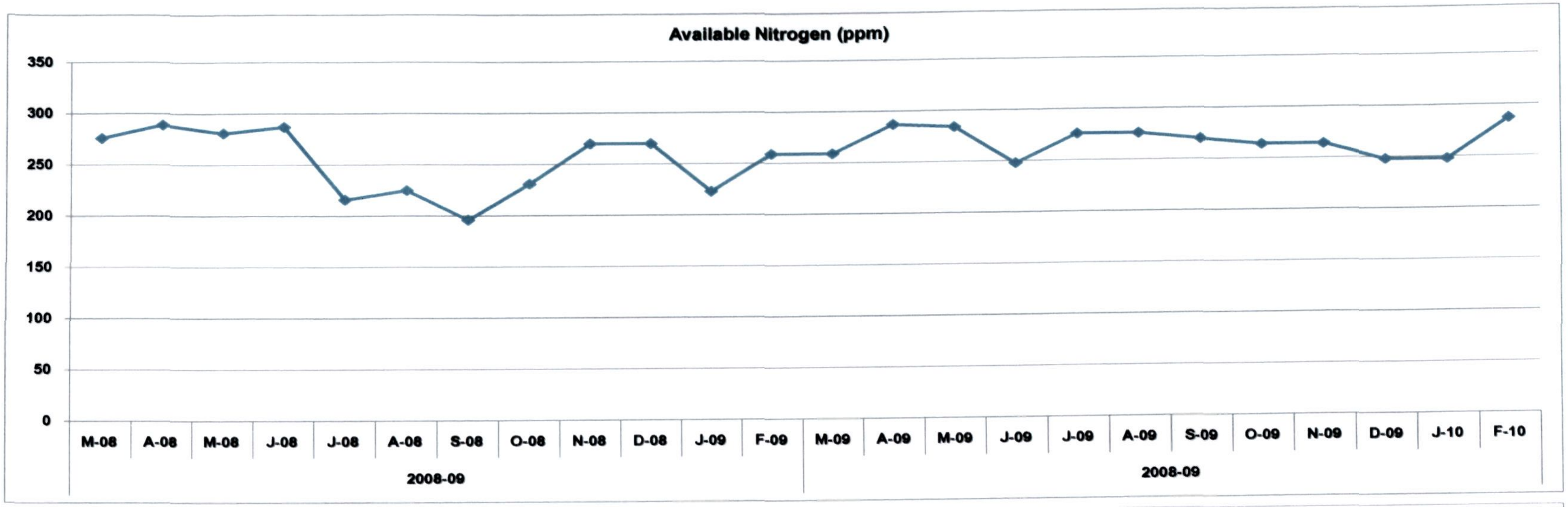


Figure 10c (iii): Fluctuation of the edaphic factors (Organic Carbon and Organic Matter) from the site of Unarable Land during 2008 – 2010



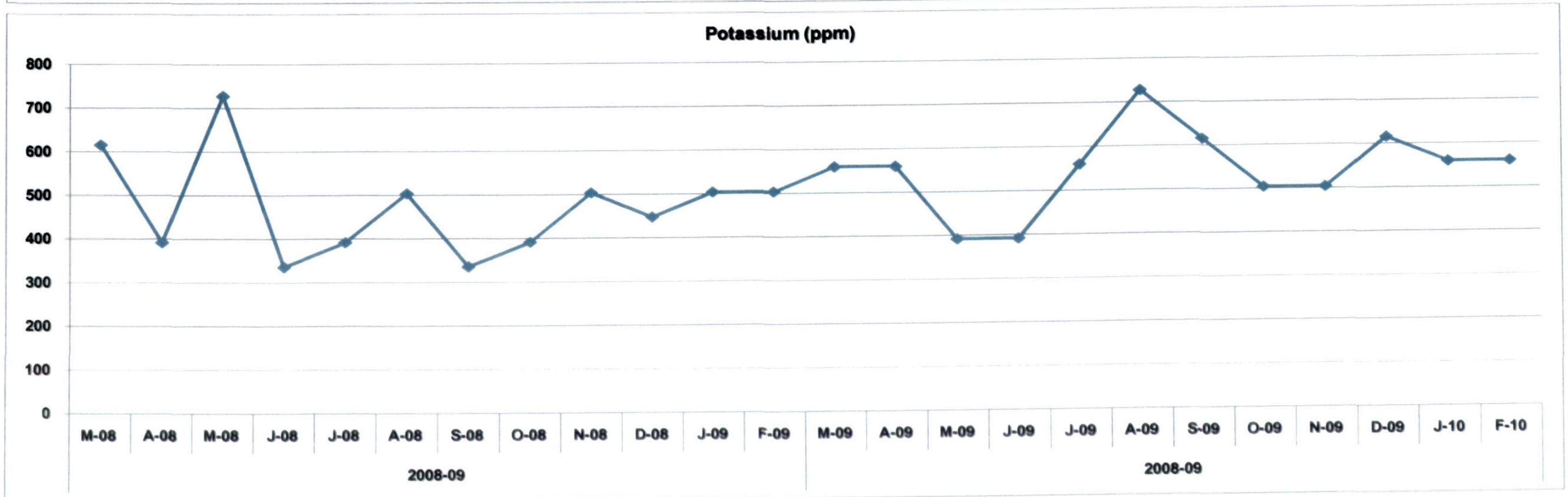


Figure 10c (iv): Fluctuation of the edaphic factors (Available Nitrogen and Potassium) from the site of Unarable Land during 2008 – 2010

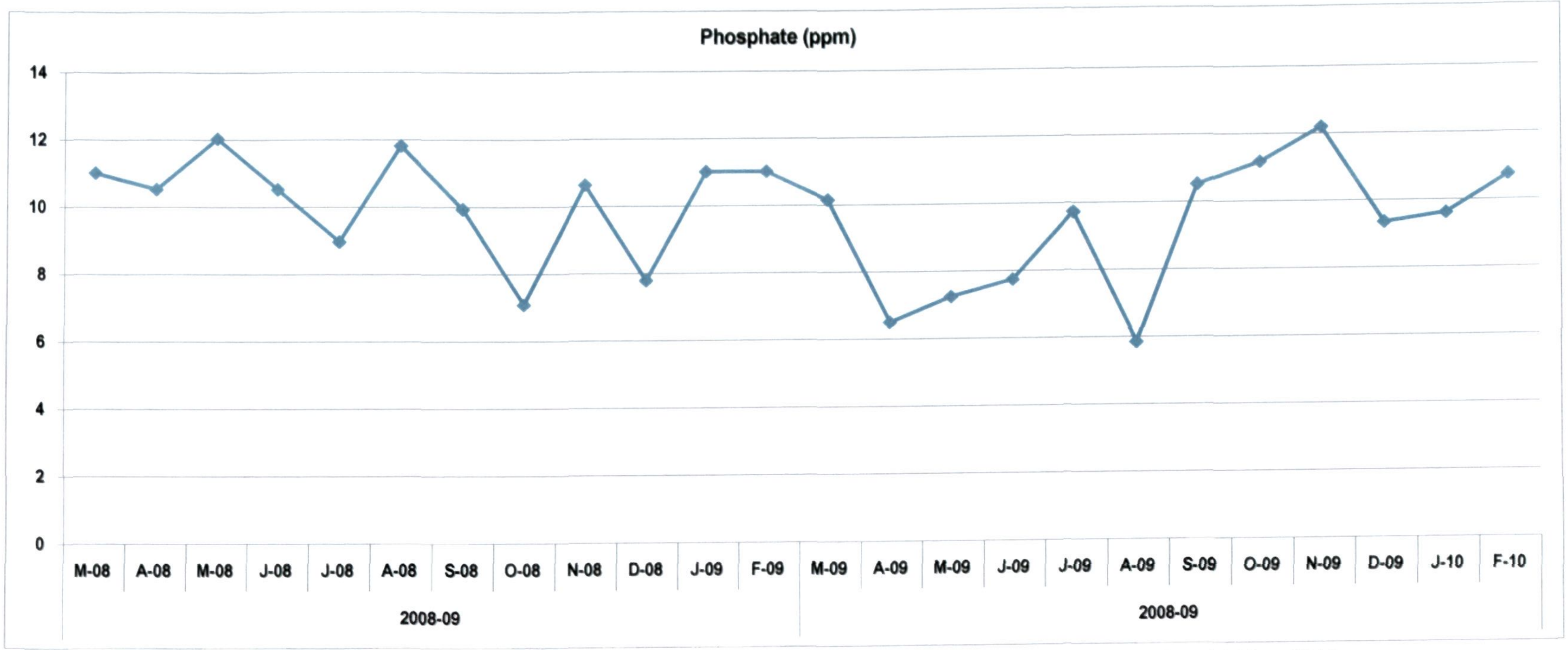


Figure 10c (v): Fluctuation of the edaphic factor (Phosphate) from the site of Unarable Land during 2008 – 2010

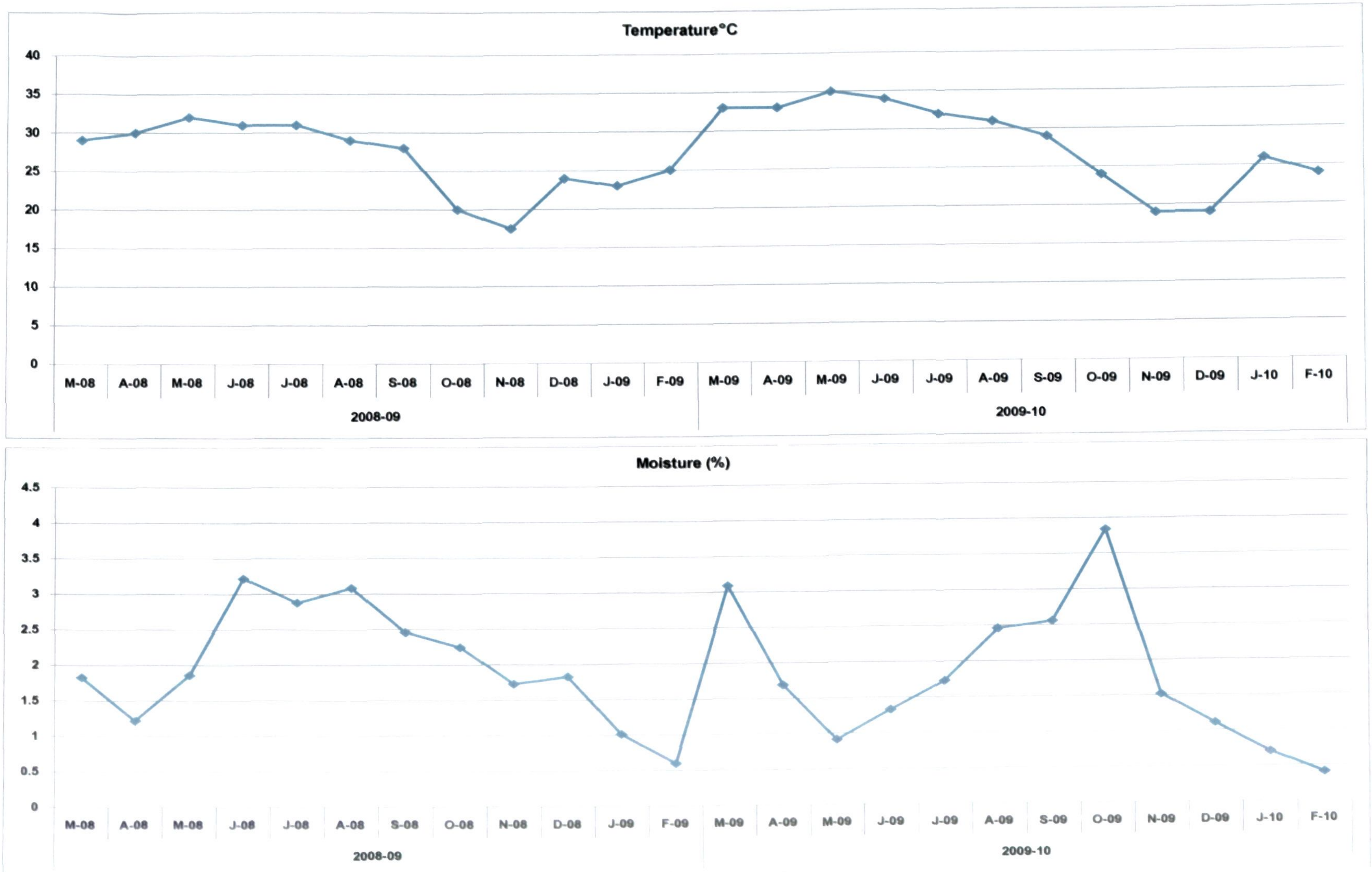


Figure 10d (i): Fluctuation of the edaphic factors (Temperature and Moisture) from the site of Wheat Field during 2008 – 2010

Figure 10d (ii): Fluctuation of the edaphic factors (Relative Humidity and pH) from the site of Wheat Field during 2008 – 2010

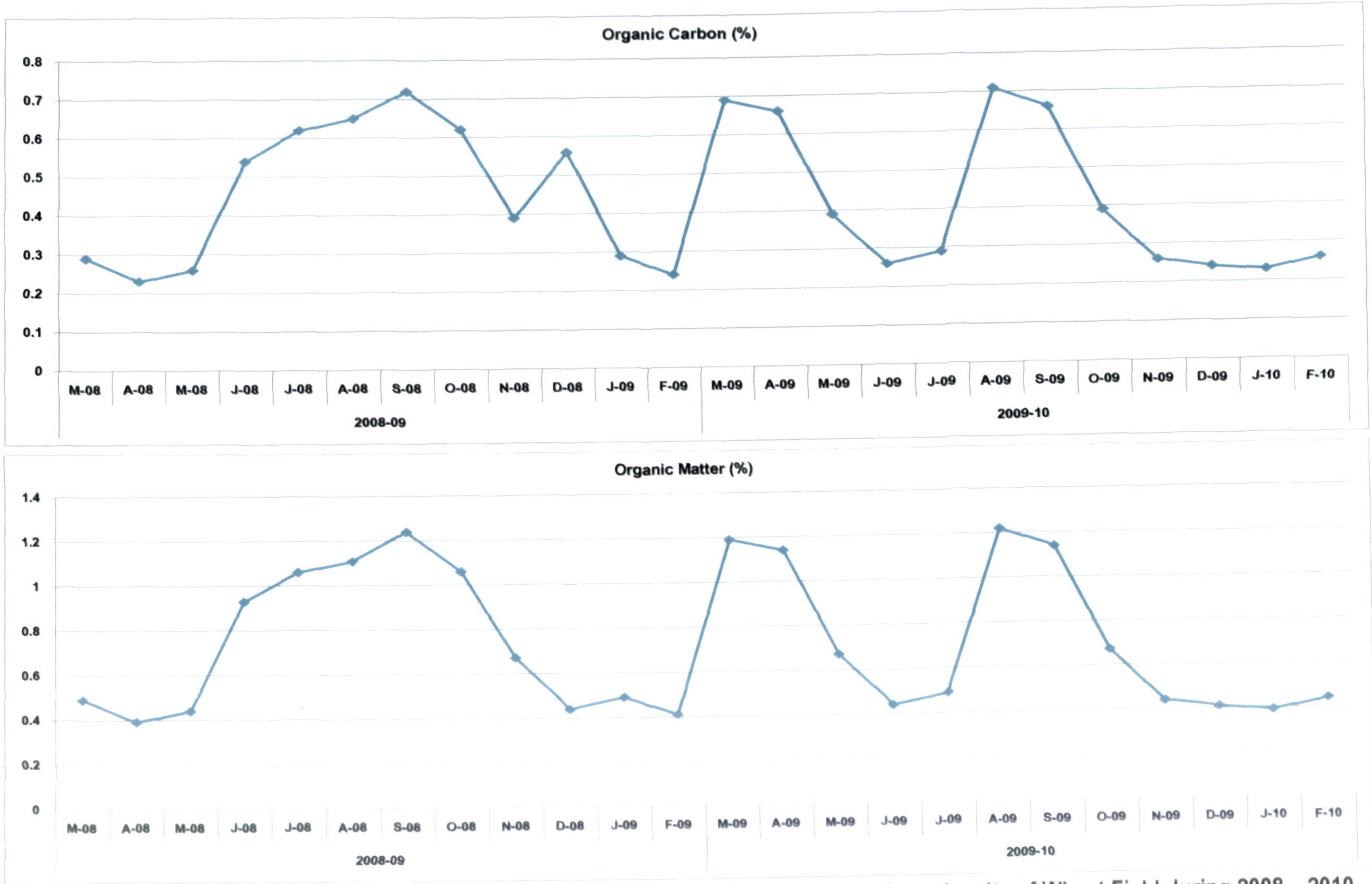
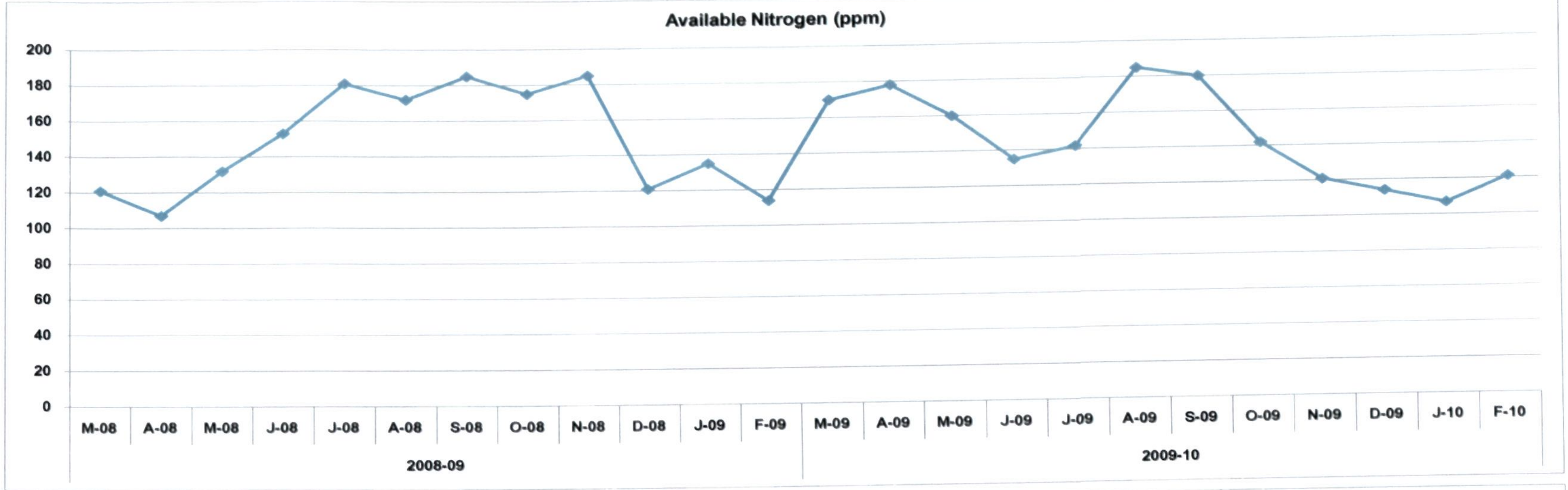


Figure 10d (iii): Fluctuation of the edaphic factors (Organic Carbon and Organic Matter) from the site of Wheat Field during 2008 – 2010



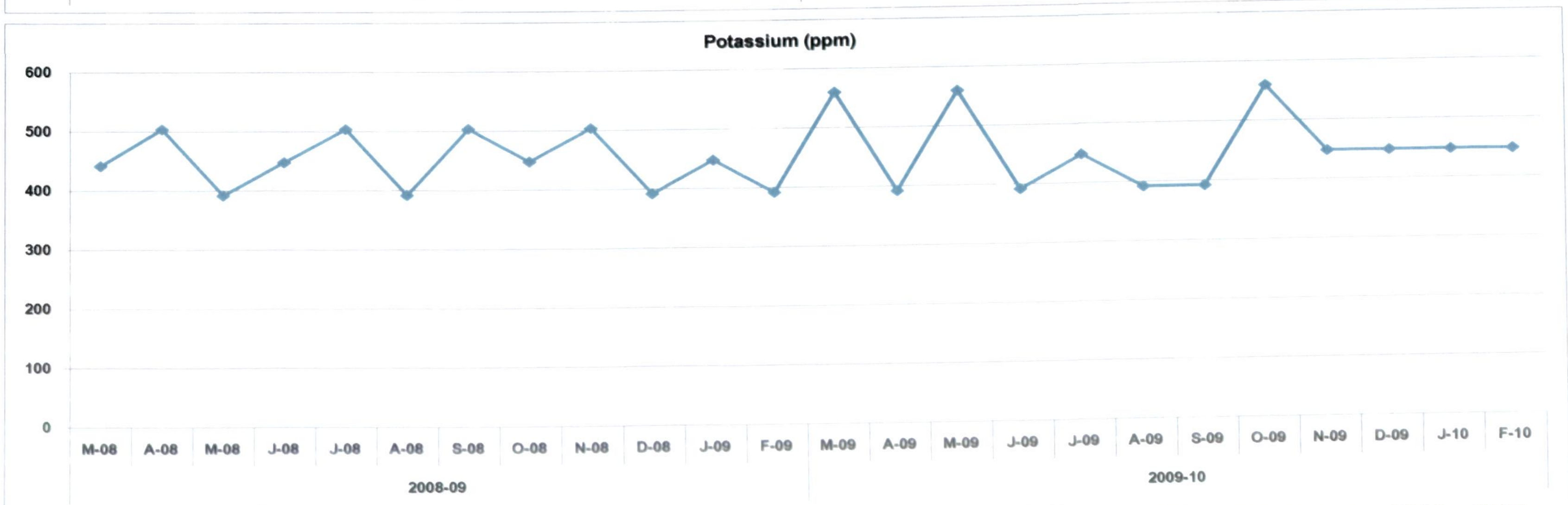


Figure 10d (iv): Fluctuation of the edaphic factors (Available Nitrogen and Potassium) from the site of Wheat Field during 2008 – 2010

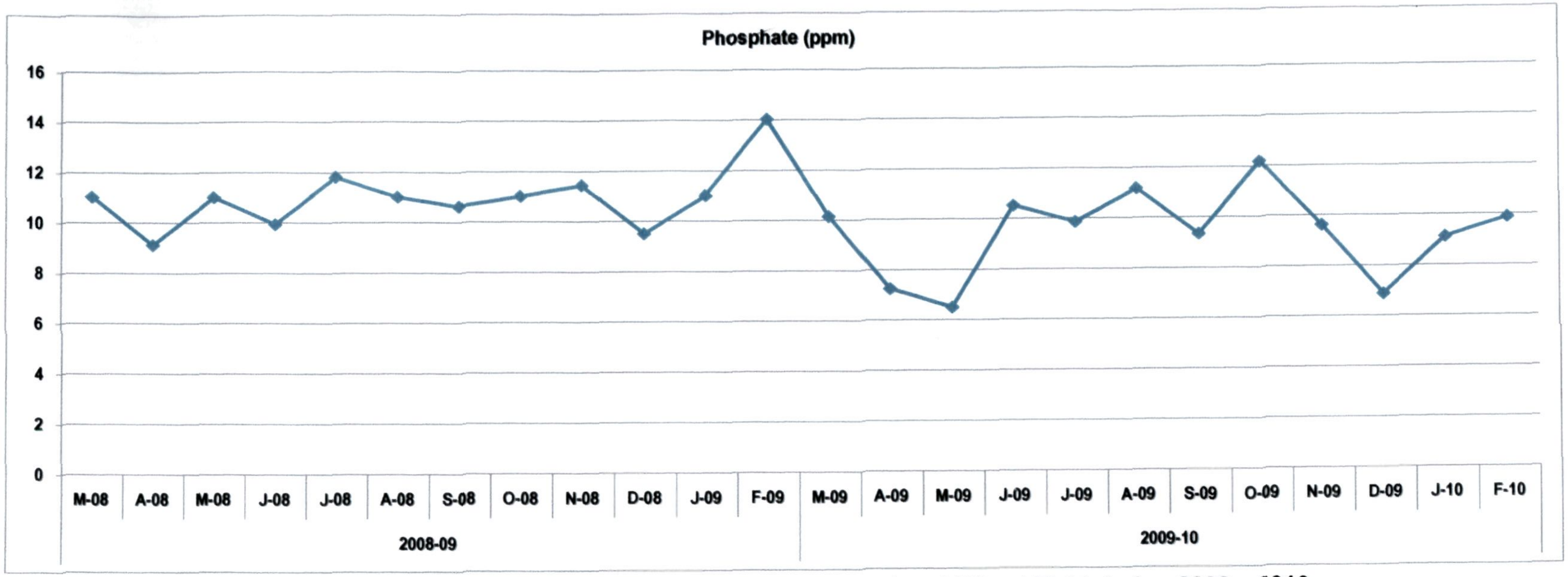


Figure 10d (v): Fluctuation of the edaphic factor (Phosphate) from the site of Wheat Field during 2008 – 2010

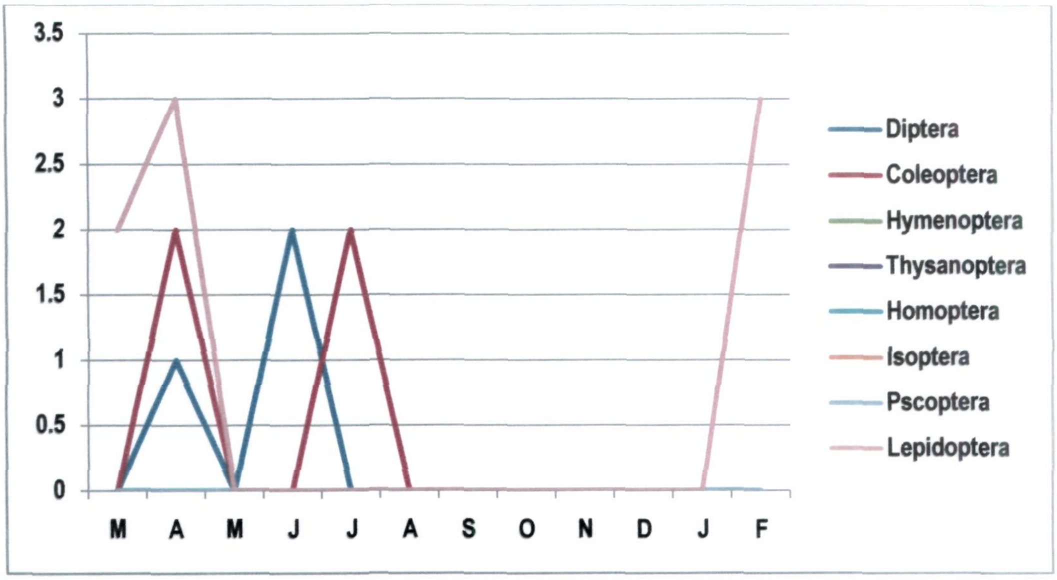


Figure 11a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2008-09

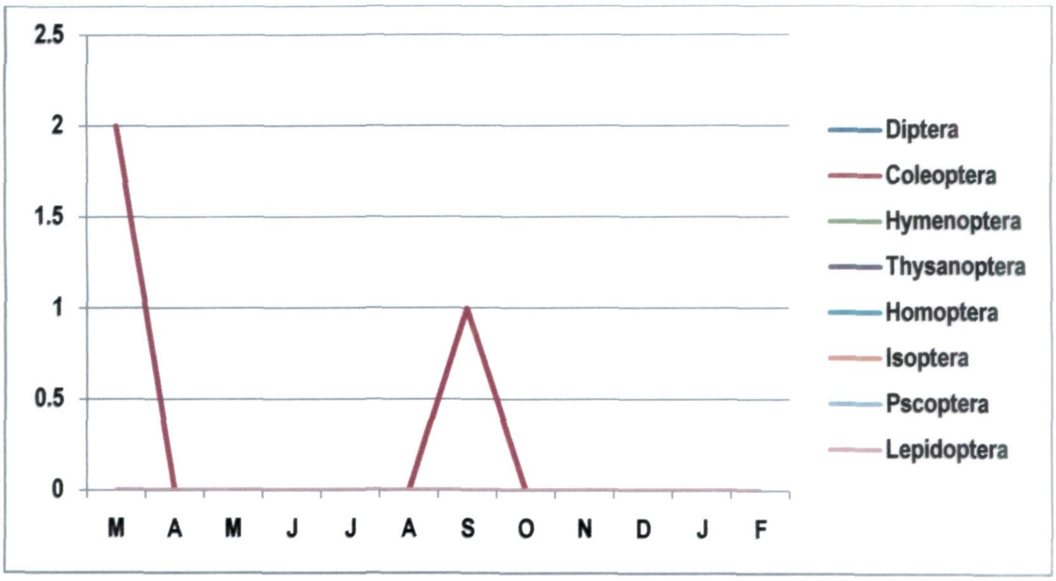


Figure 11b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Mango Orchards during 2008-09

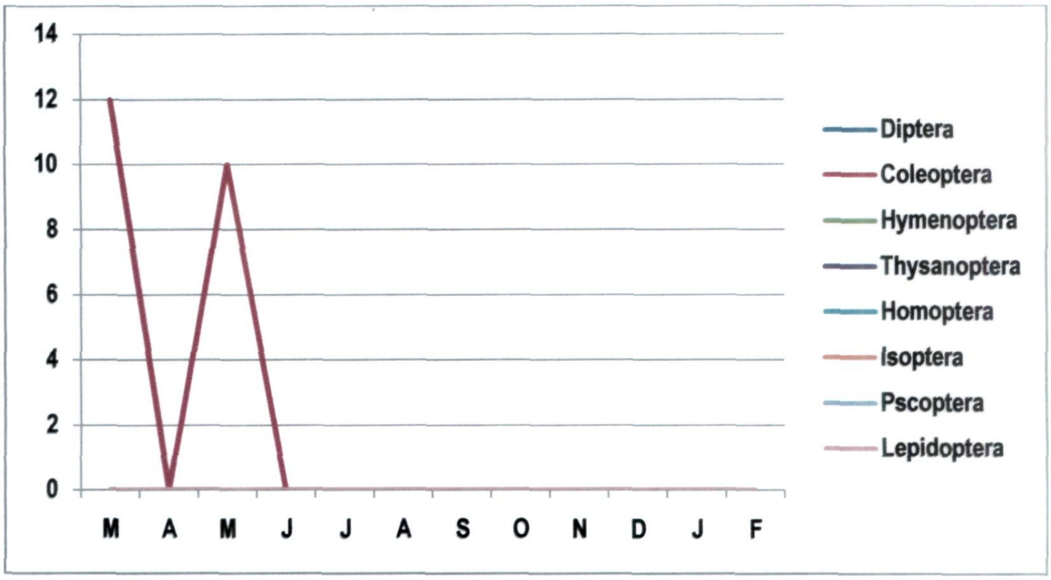


Figure 11c: Larval population fluctuation of Pterygote insects from the Litter at the site of Mango Orchards during 2008-09

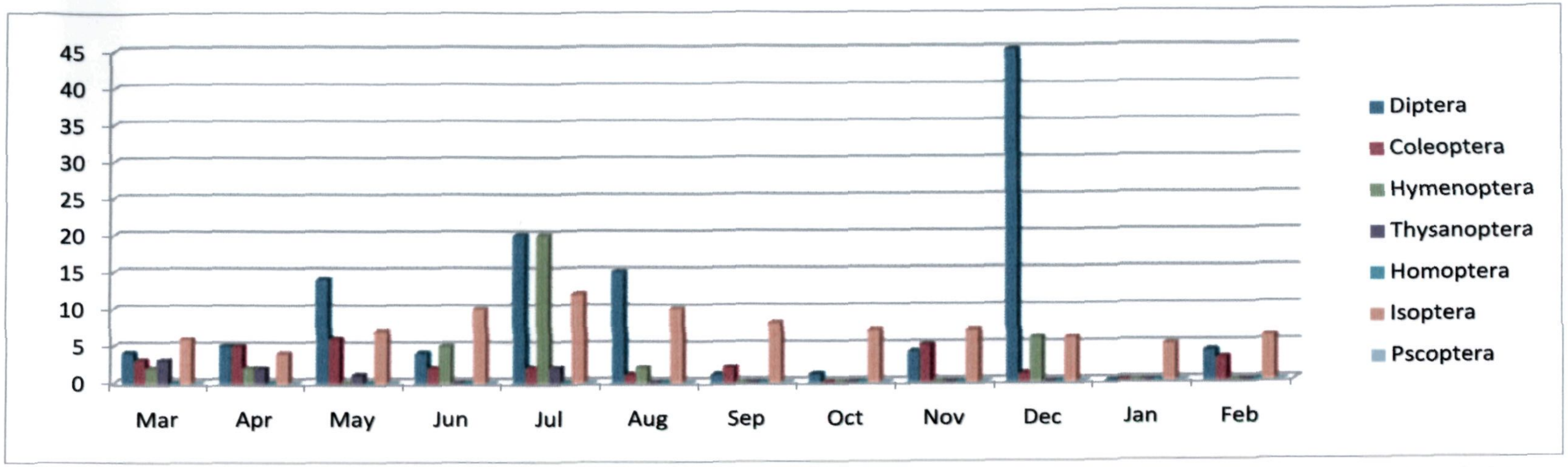


Figure 11d: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2008-09

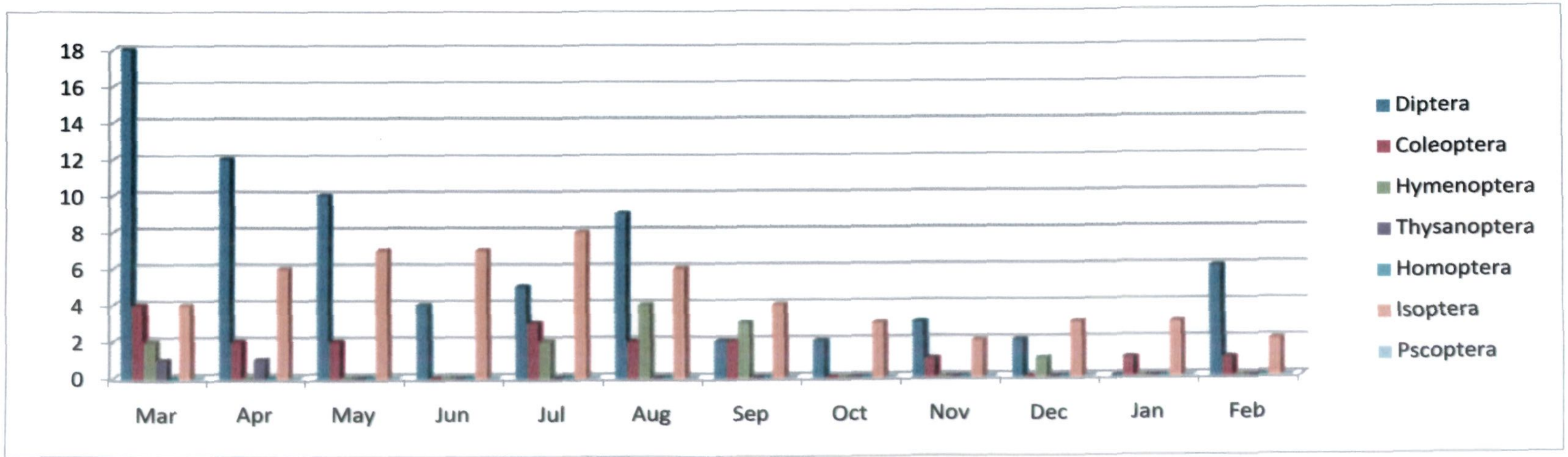


Figure 11e: Population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Mango Orchards during 2008-09

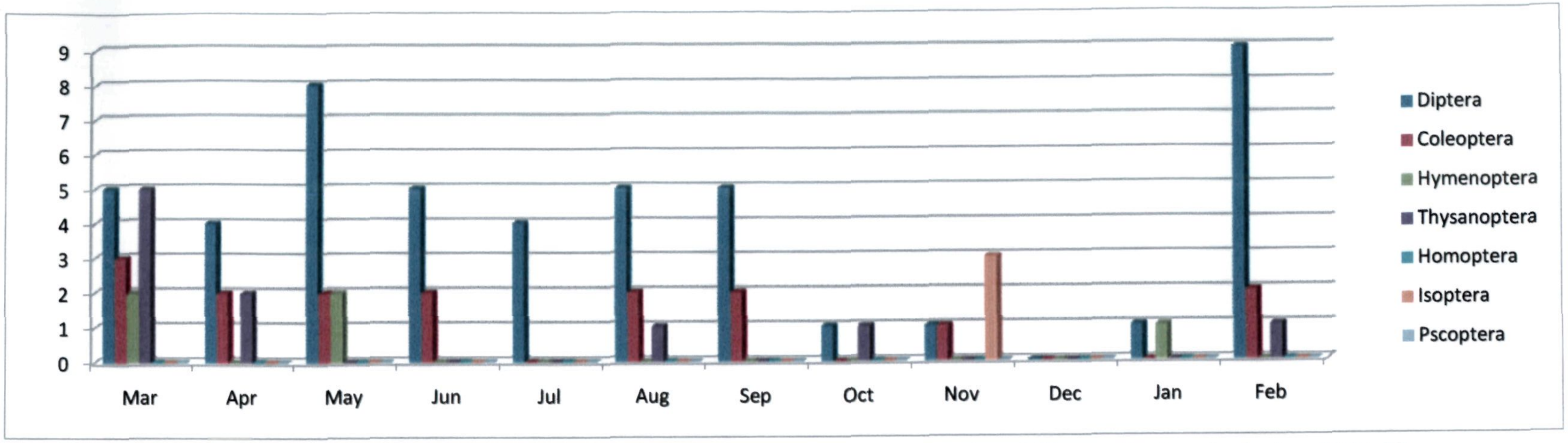


Figure 11f: Population fluctuation of Pterygote insects from the Litter at the site of Mango Orchards during 2008-09

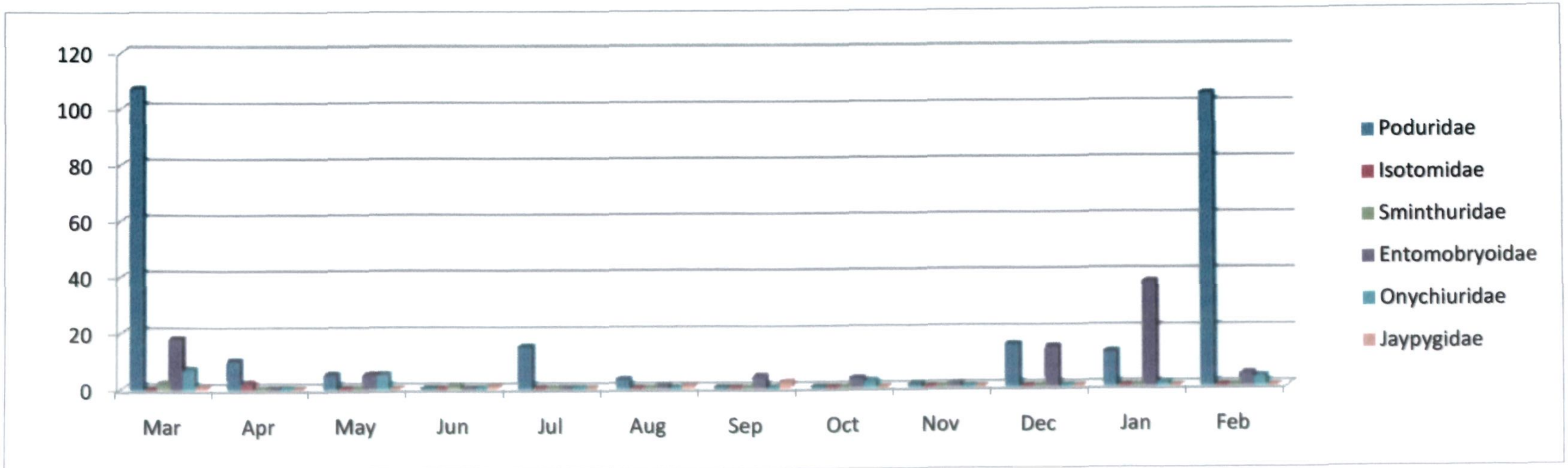


Figure 11g: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2008-09

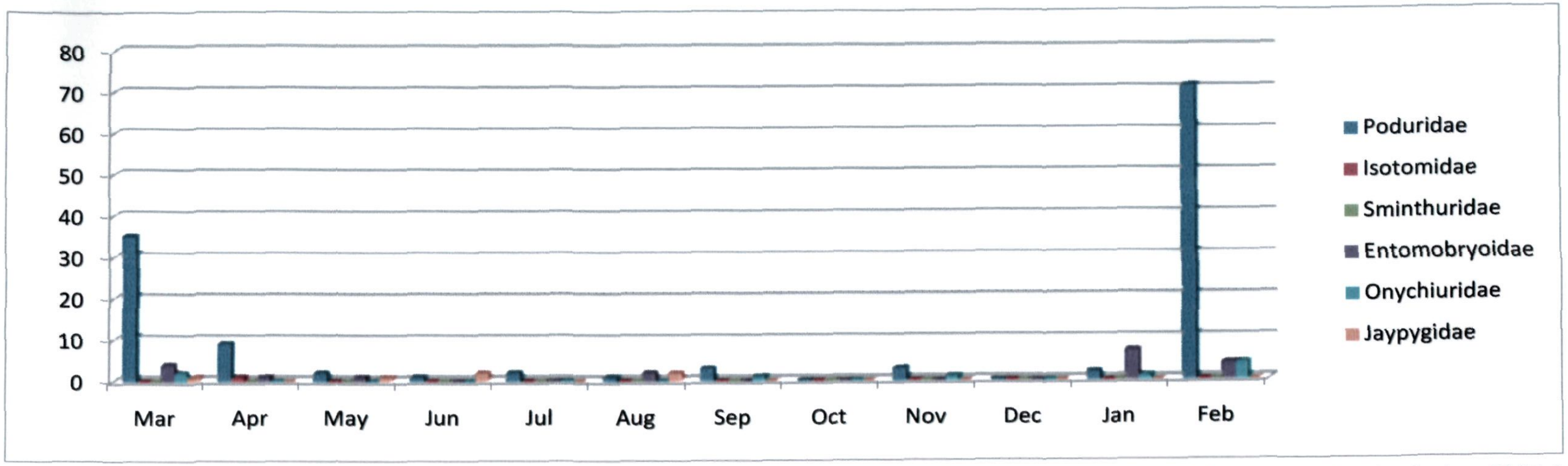


Figure 11h: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Mango Orchards during 2008-09

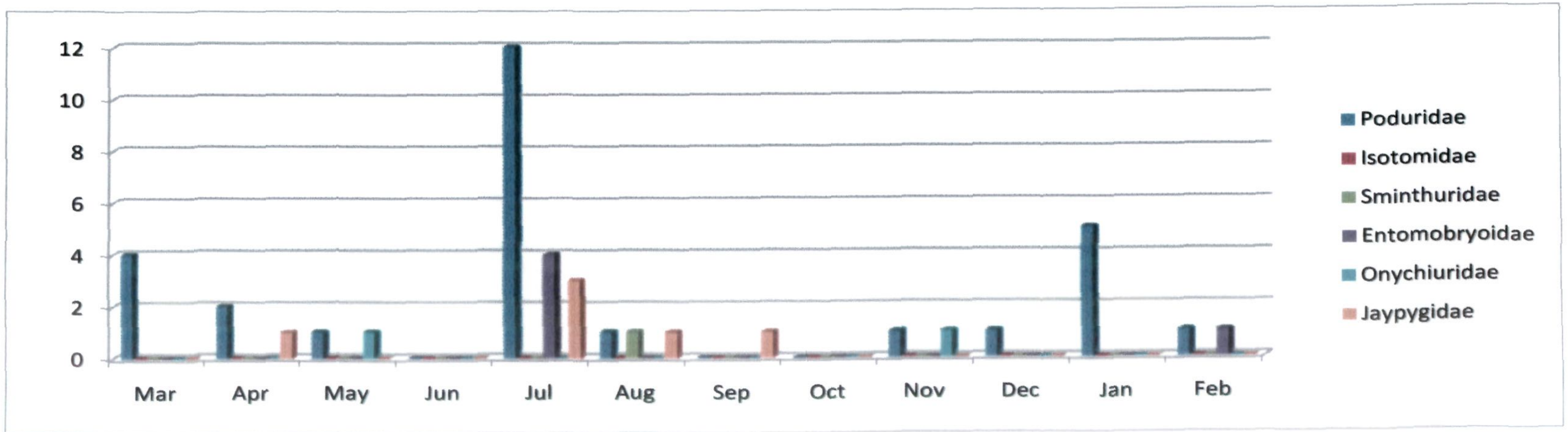


Figure 11i: Population fluctuation of Apterygote insects from the Litter at the site of Mango Orchards during 2008-09

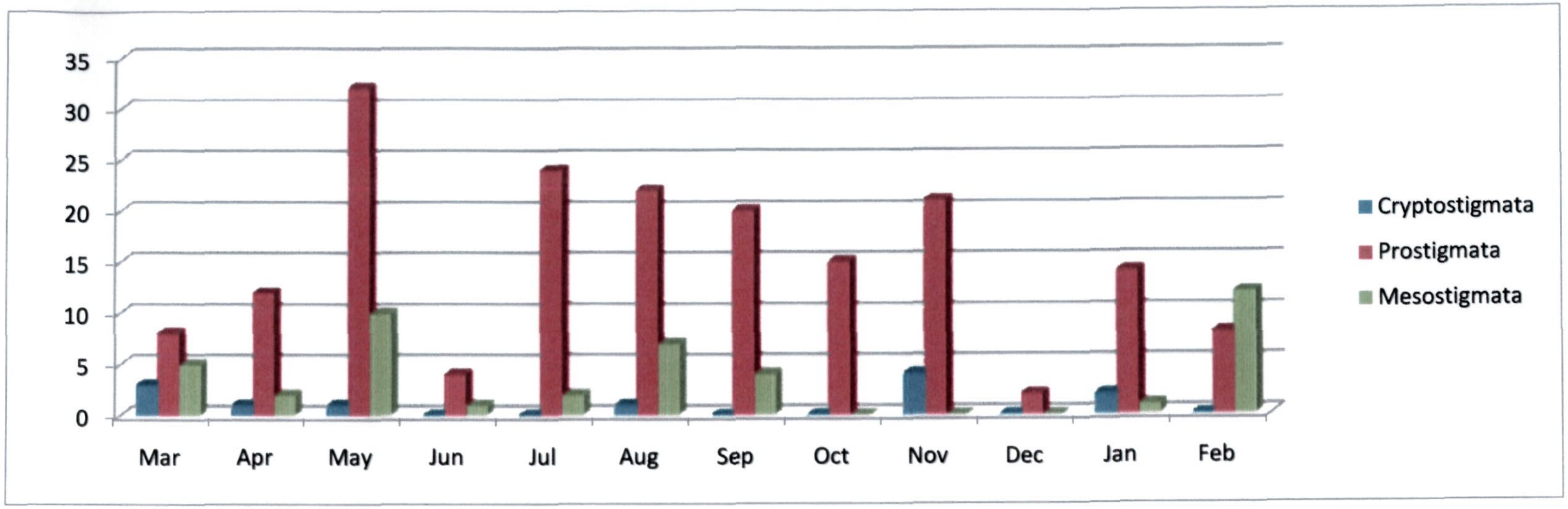


Figure 11j: Population fluctuation of Mites from the depth of 0-5cm at the site of Mango Orchards during 2008-09

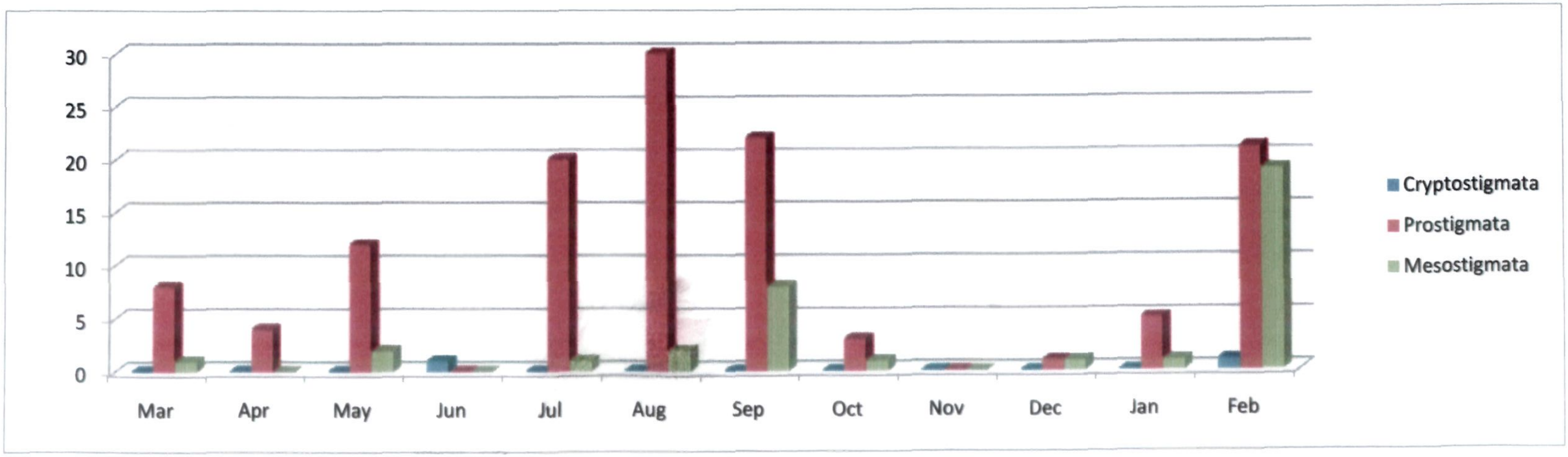


Figure 11k: Population fluctuation of Mites from the depth of 5-10cm at the site of Mango Orchards during 2008-09

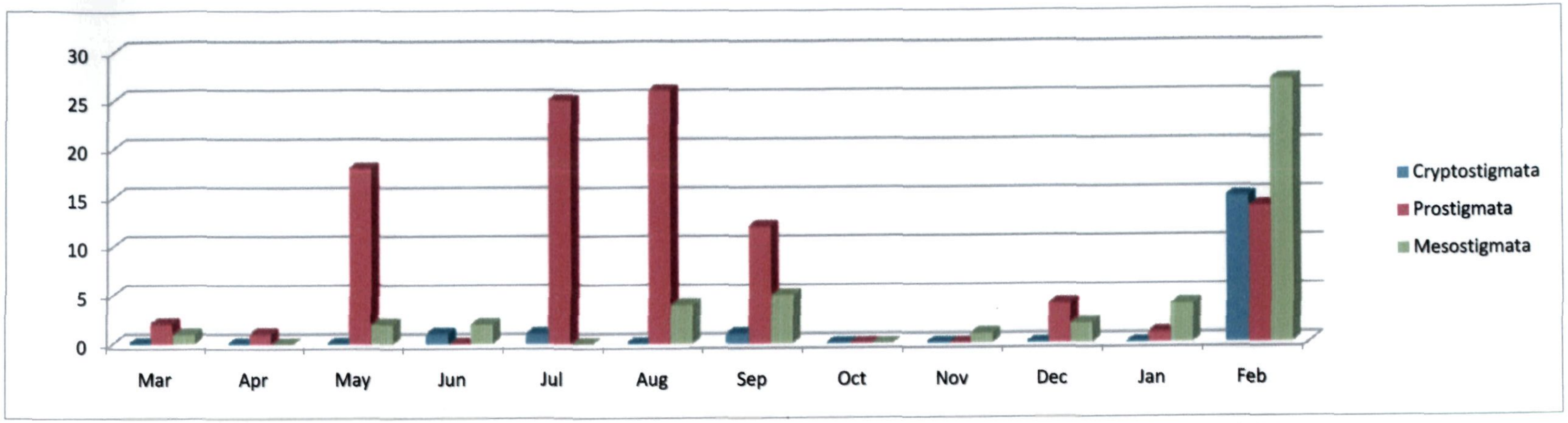


Figure 11I: Population fluctuation of Mites from the Litter at the site of Mango Orchards during 2008-09

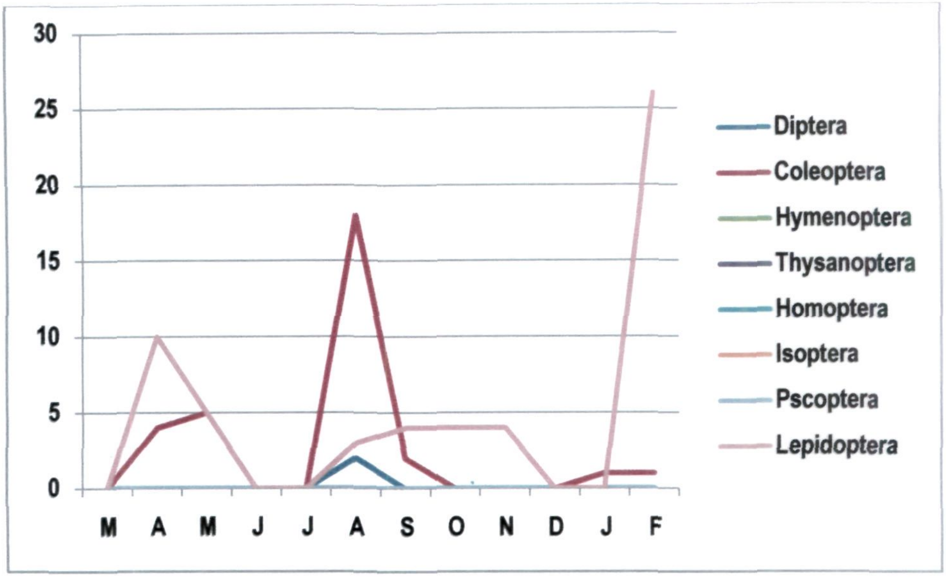


Figure 12a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2008-09

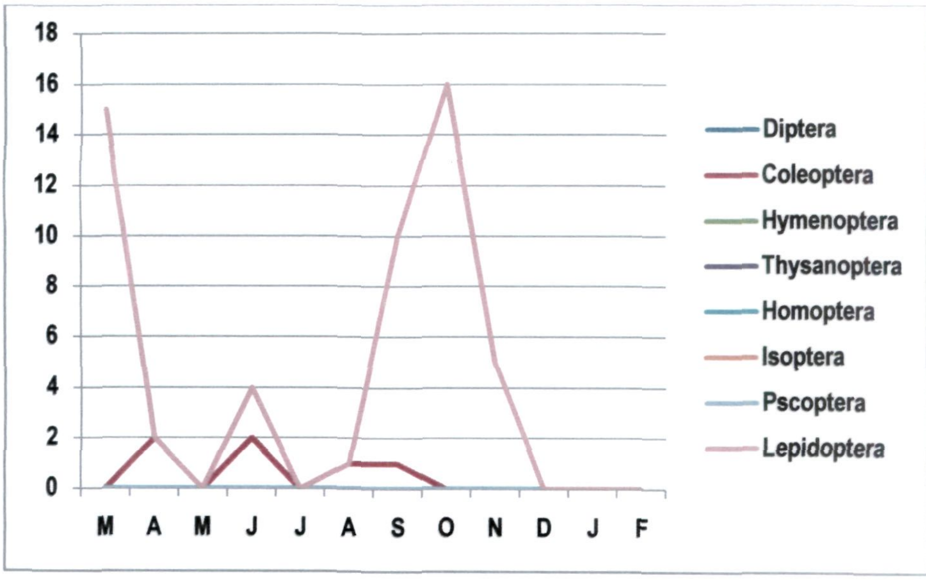


Figure 12b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2008-09

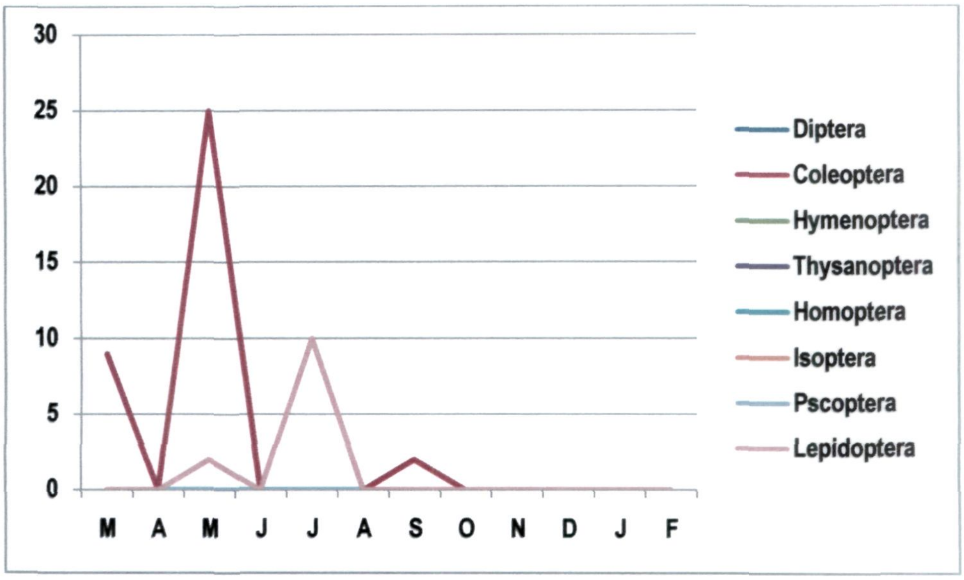


Figure 12c: Larval population fluctuation of Pterygote insects from the Litter at the site of Teak Plantation during 2008-09

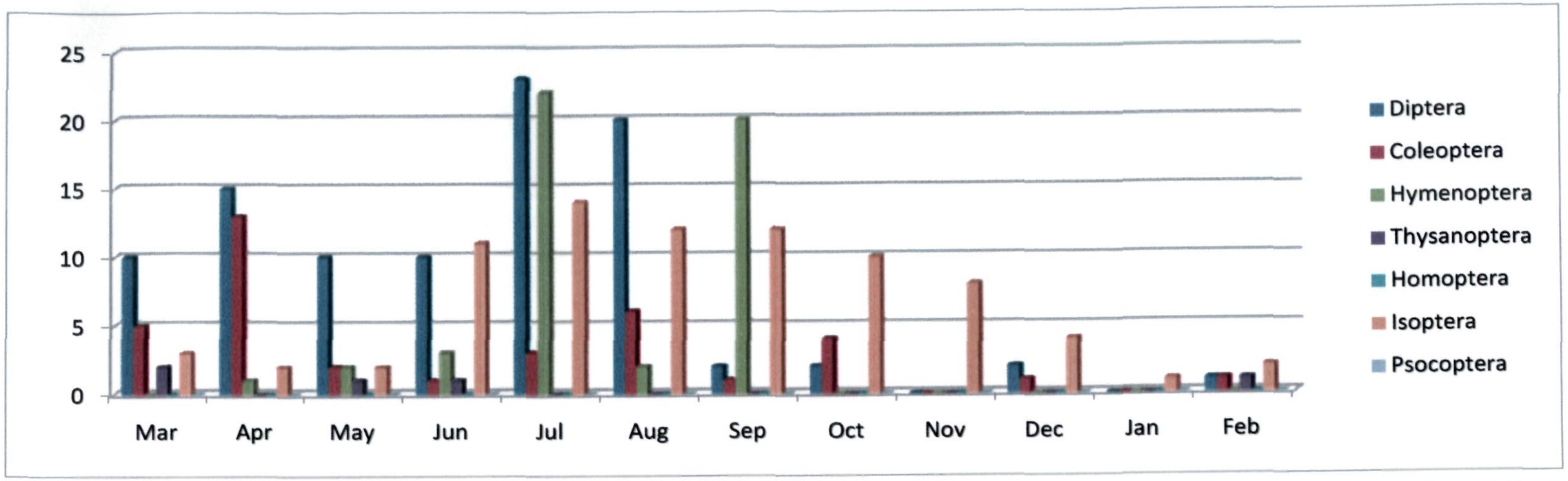


Figure 12d: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2008-09

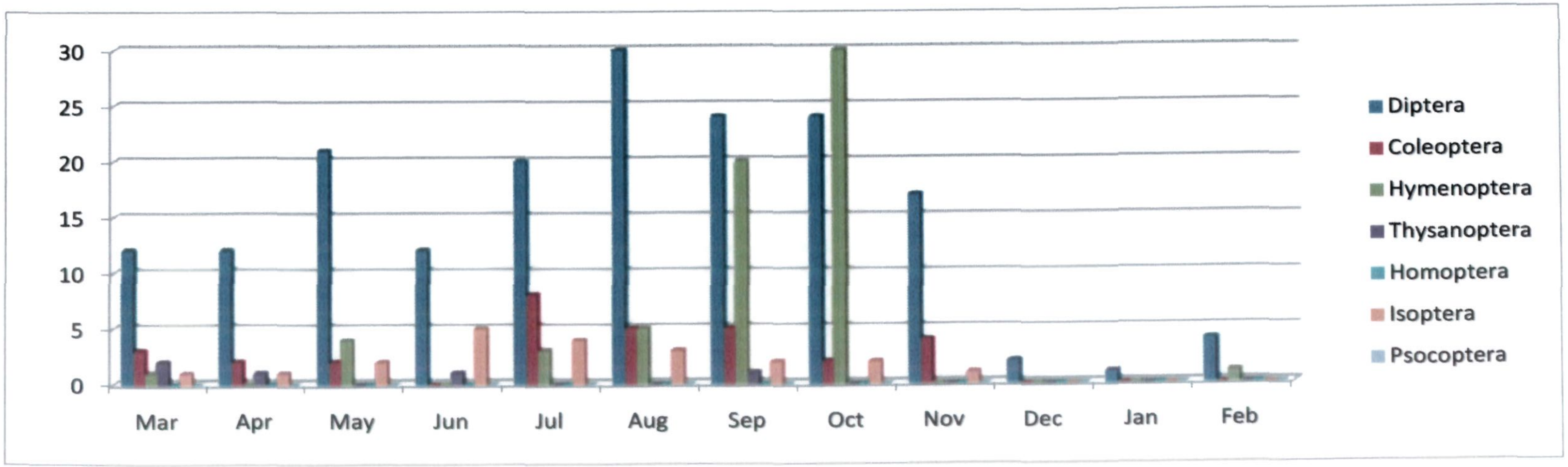


Figure 12e: Population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2008-09

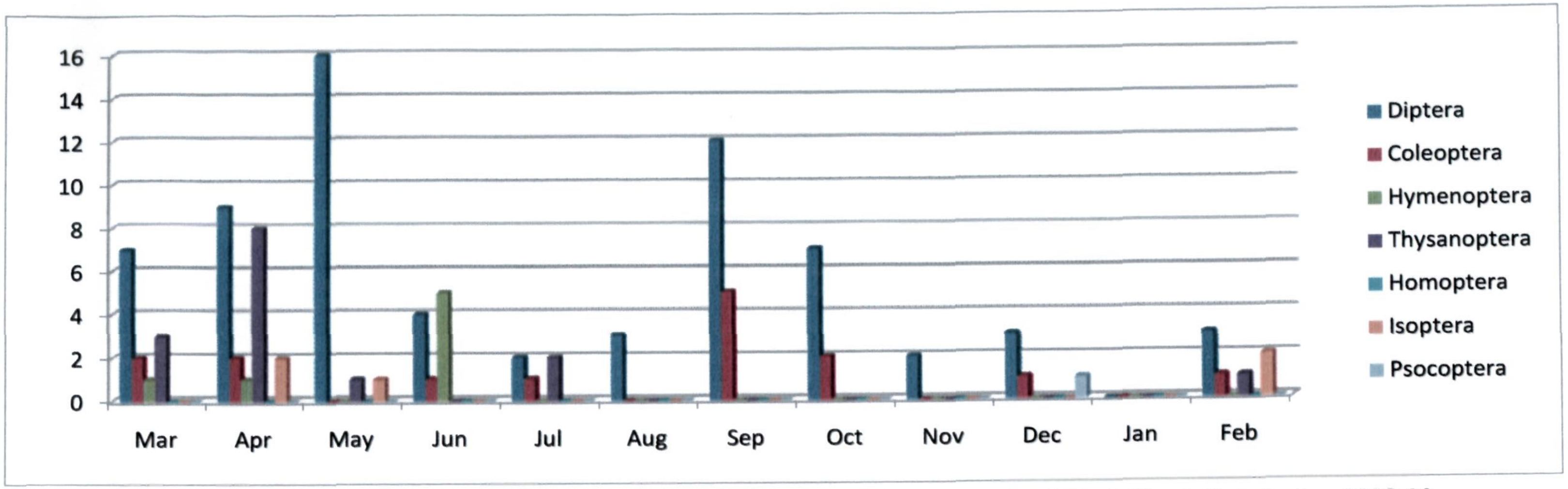


Figure 12f: Population fluctuation of Pterygote insects from the Litter at the site of Teak Plantation during 2008-09

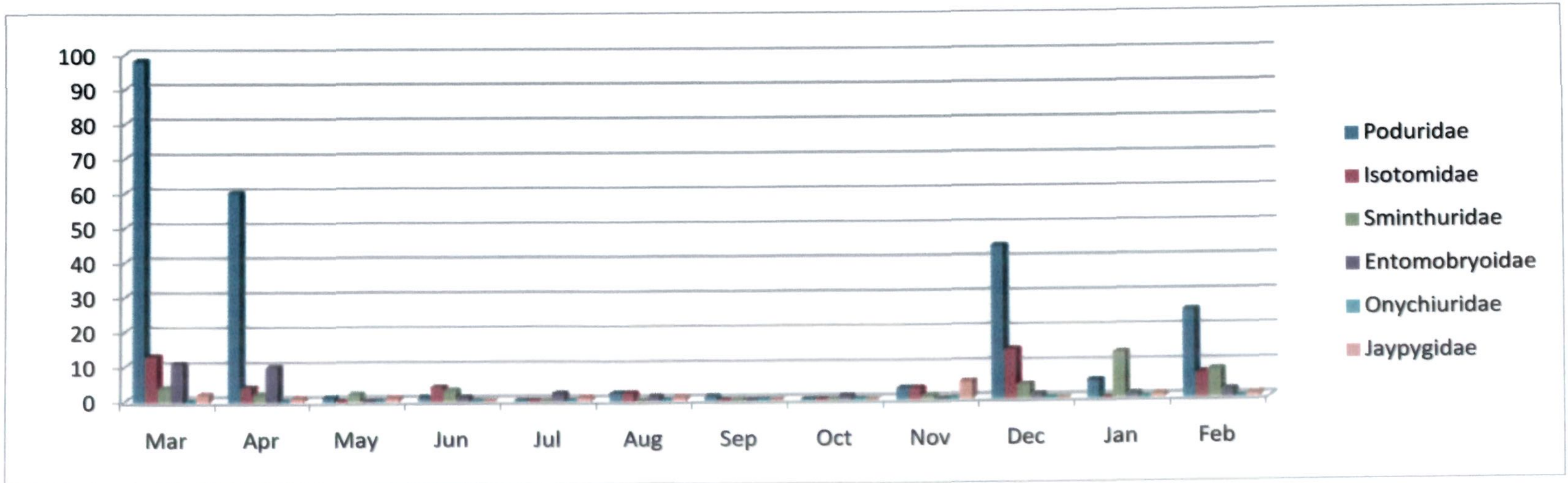


Figure 12g: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2008-09

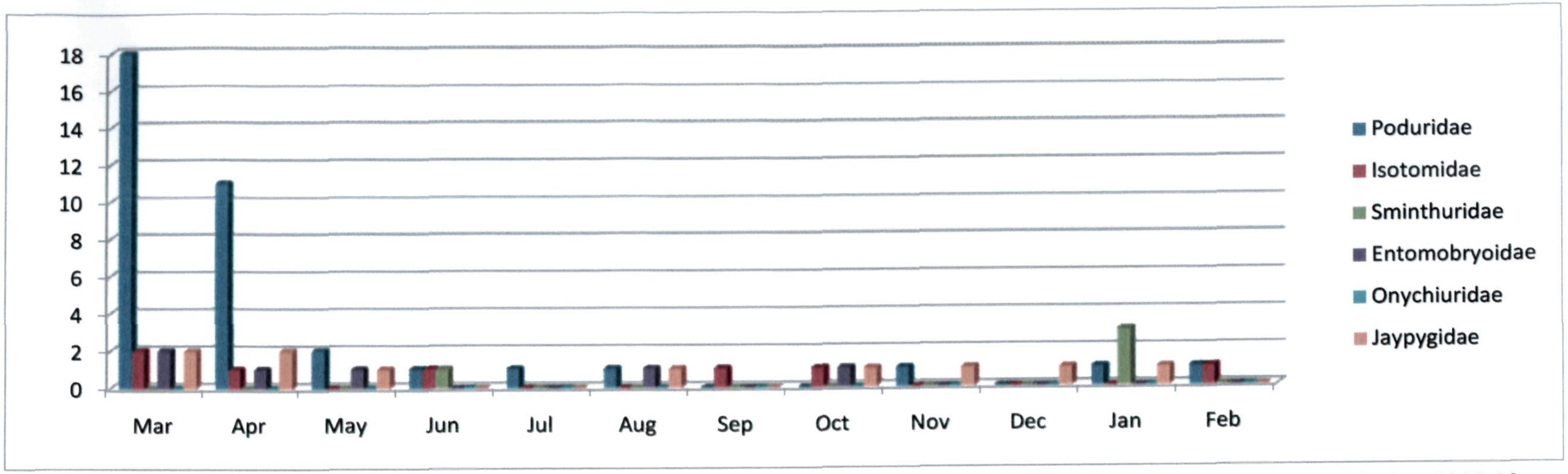


Figure 12h: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2008-09

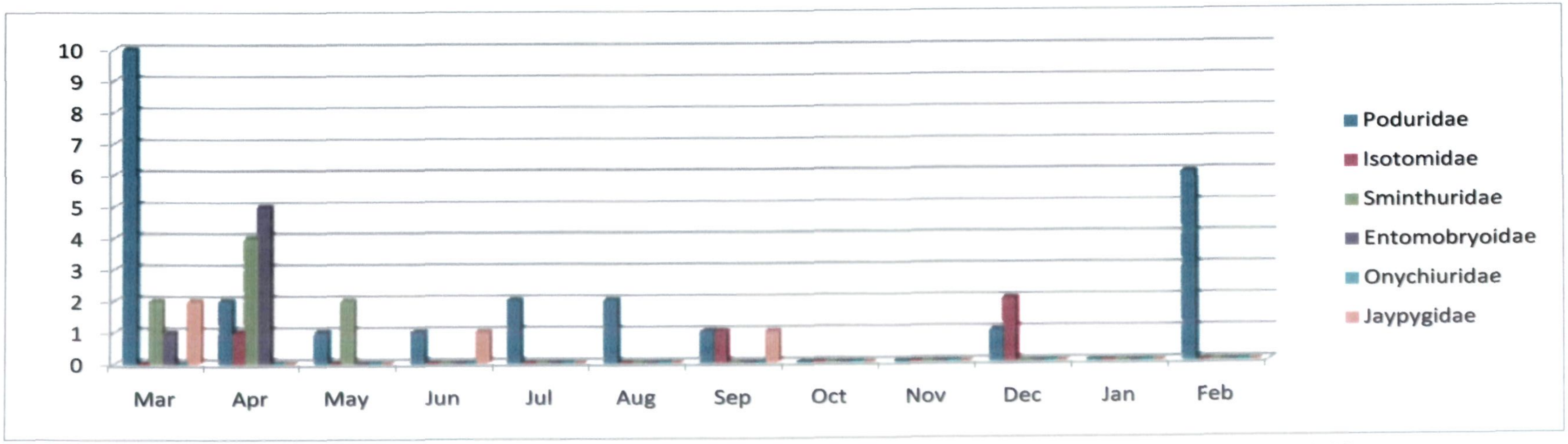


Figure 12i: Population fluctuation of Pterygote insects from the Litter at the site of Teak Plantation during 2008-09

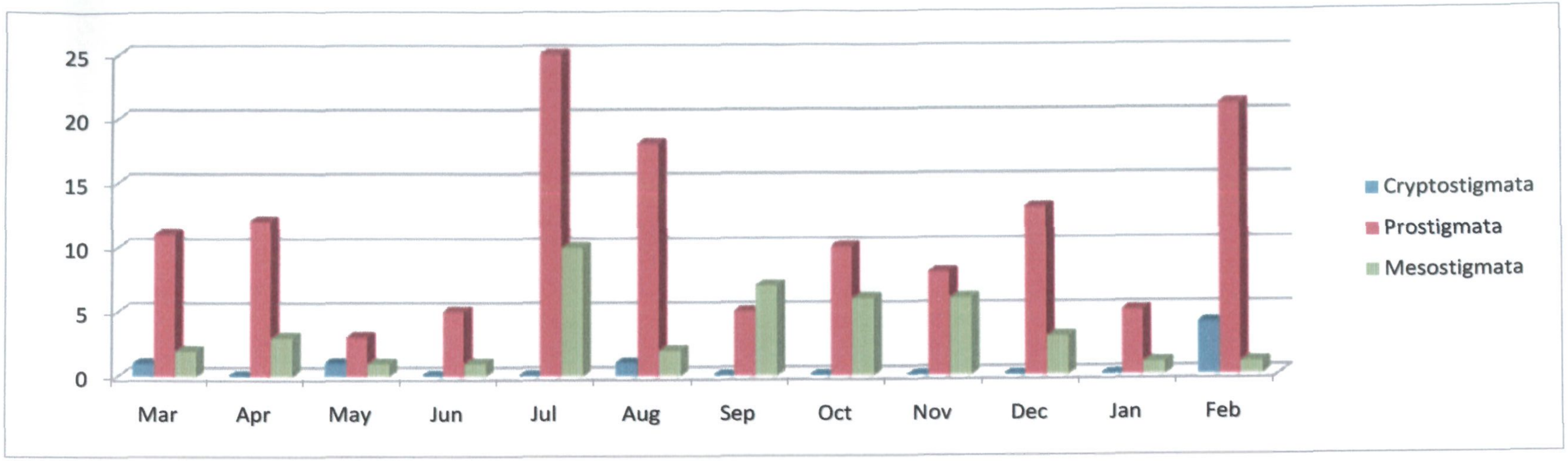


Figure 12j: Population fluctuation of Mites from the depth of 0-5cm at the site of Teak Plantation during 2008-09

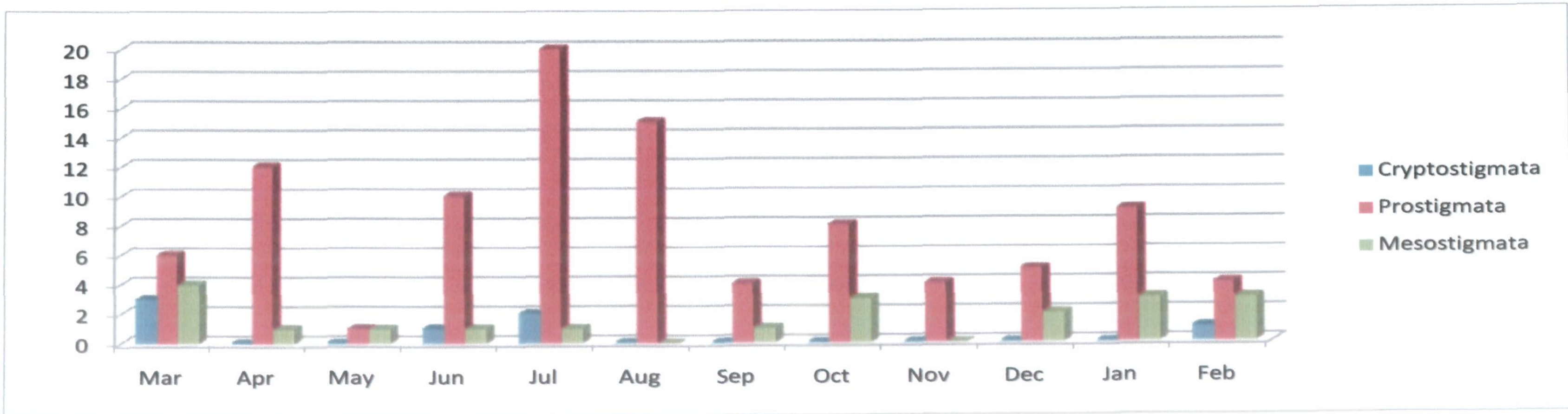


Figure 12k: Population fluctuation of Mites from the depth of 5-10cm at the site of Teak Plantation during 2008-09

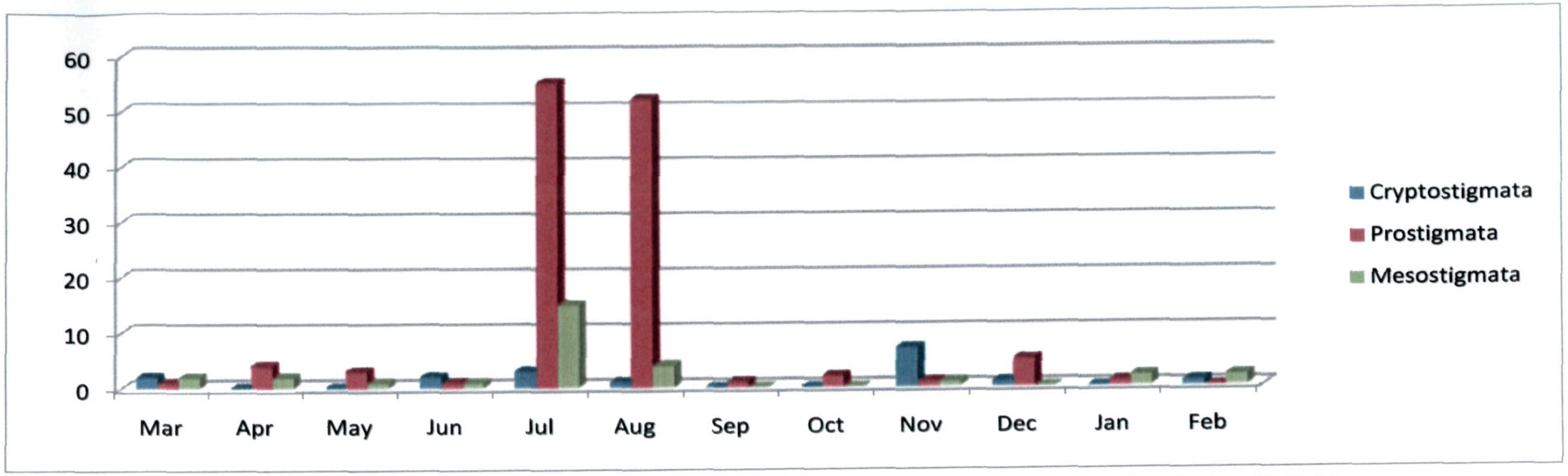


Figure 12l: Population fluctuation of Mites from the depth of Litter at the site of Teak Plantation during 2008-09

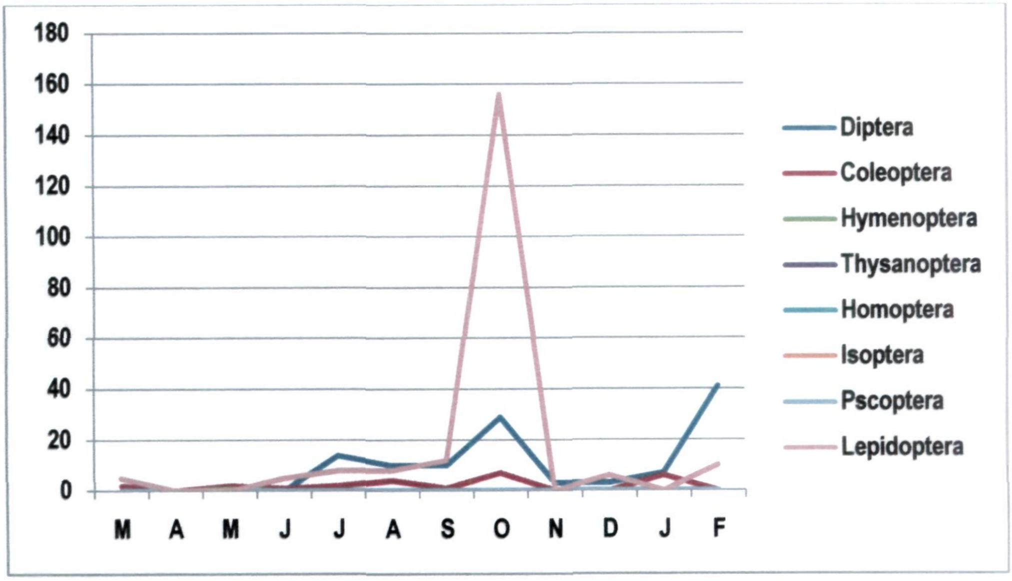


Figure 13a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Unarable Land during 2008-09

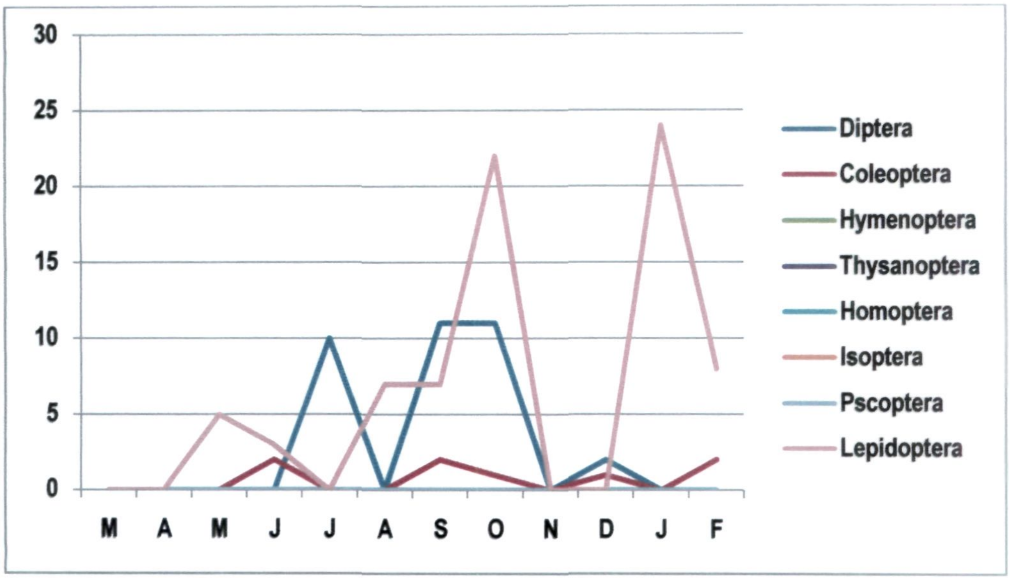


Figure 13b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Unarable Land during 2008-09

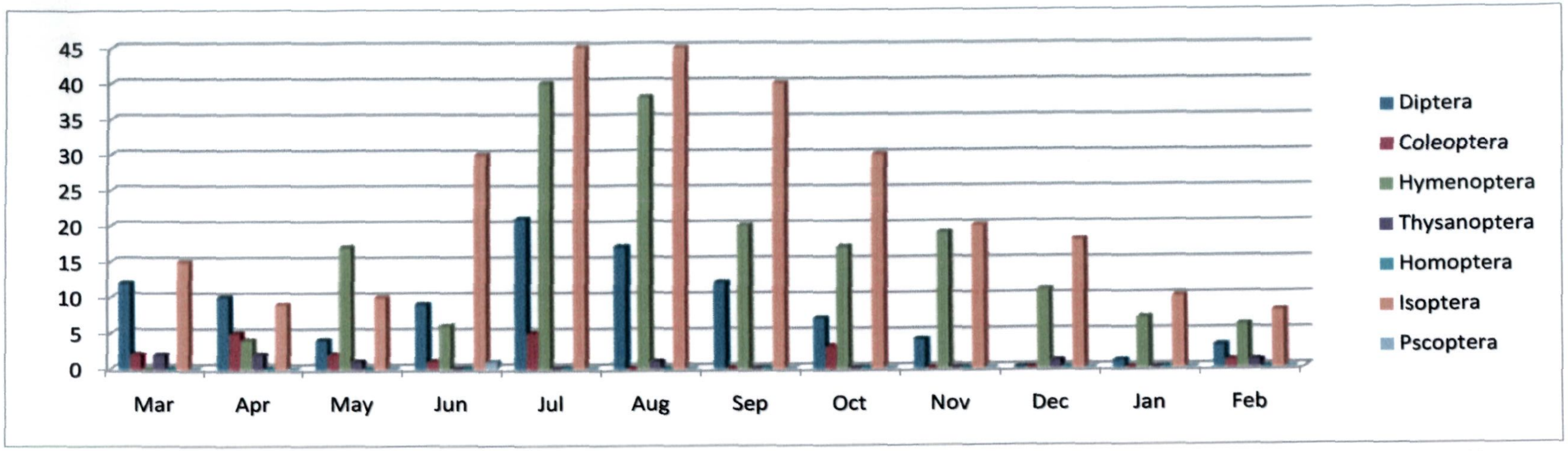


Figure 13c: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Unarable Land during 2008-09

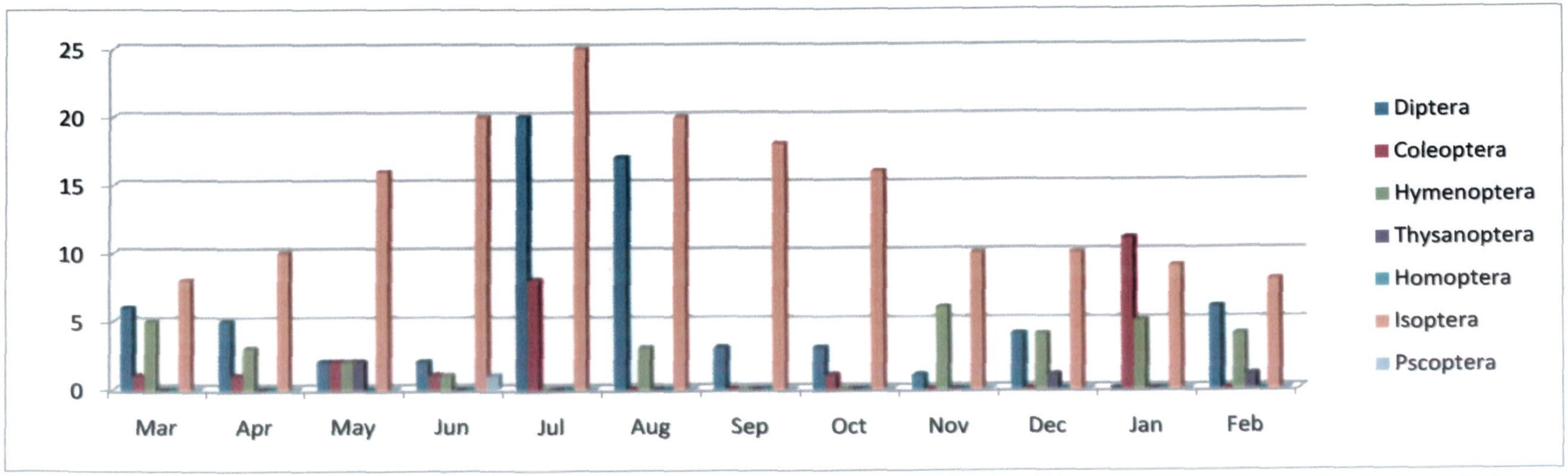


Figure 13d: Population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Unarable Land during 2008-09

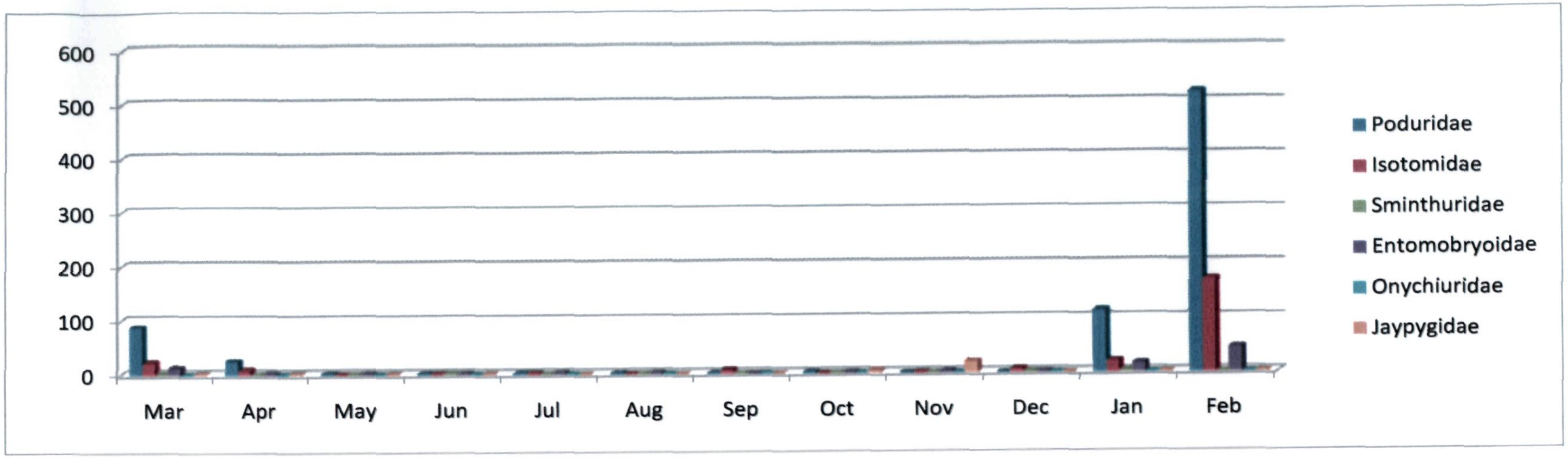


Figure 13e: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Unarable Land during 2008-09

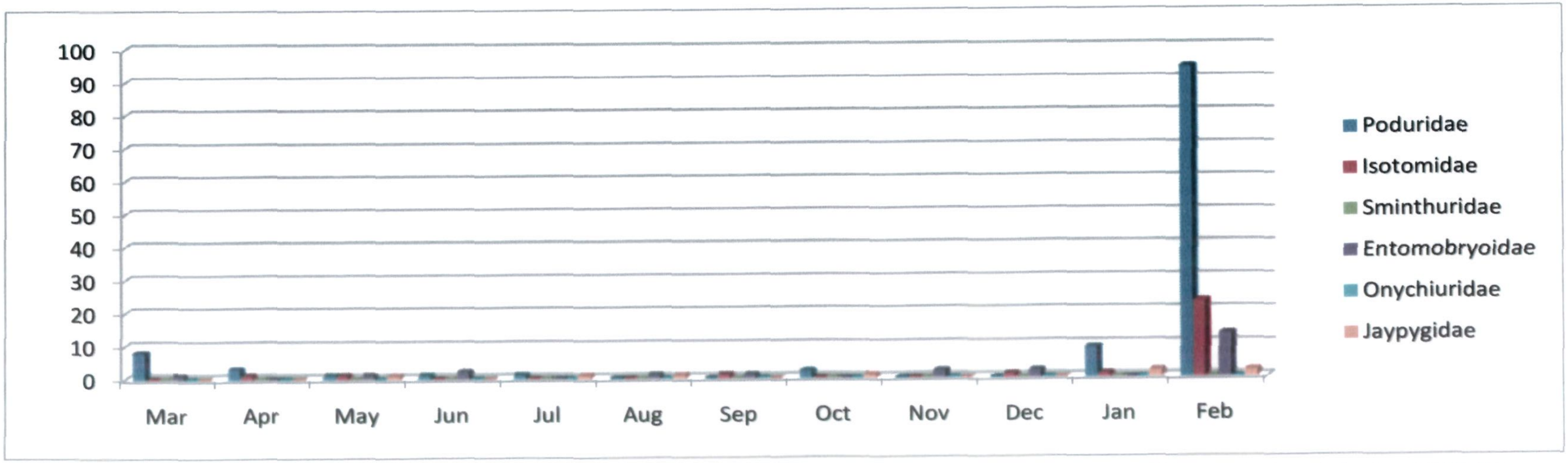


Figure 13f: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Unarable Land during 2008-09

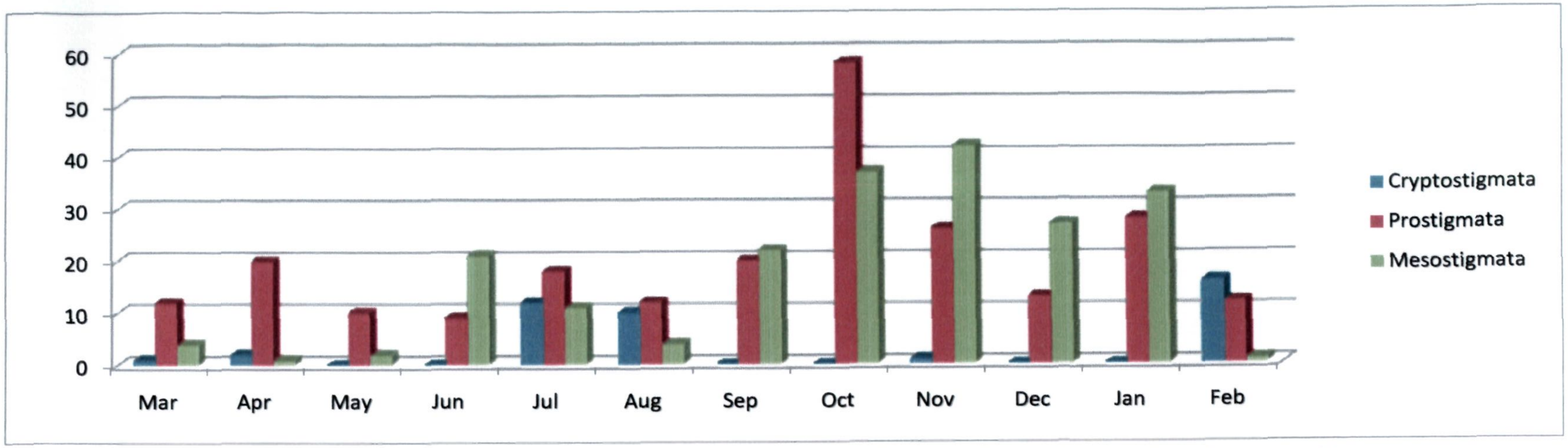


Figure 13g: Population fluctuation of Mites from the depth of 0-5cm at the site of Unarable Land during 2008-09

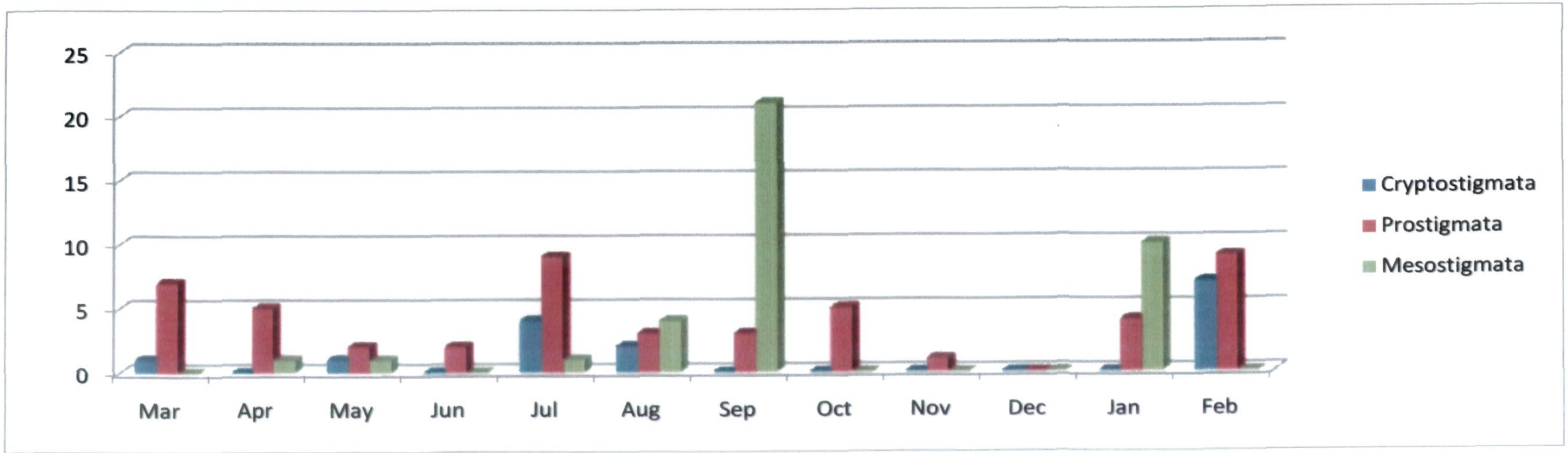


Figure 13h: Population fluctuation of Mites from the depth of 5-10cm at the site of Unarable Land during 2008-09

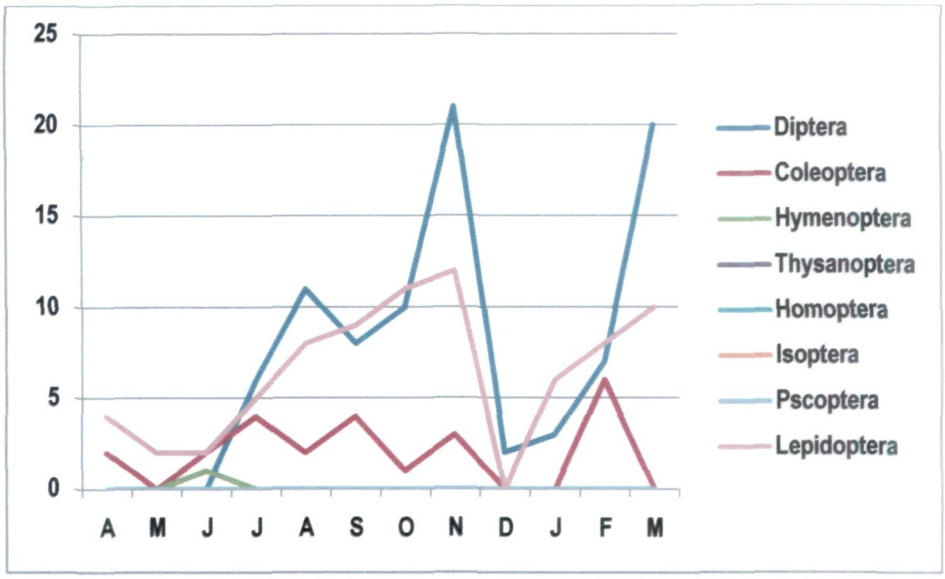


Figure 14a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Wheat Field during 2008-09

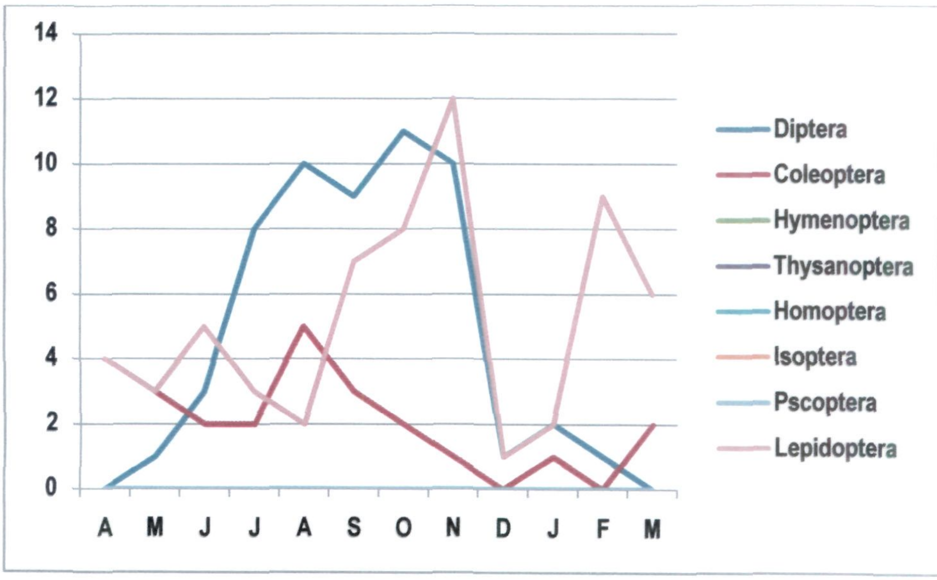


Figure 14b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Wheat Field during 2008-09

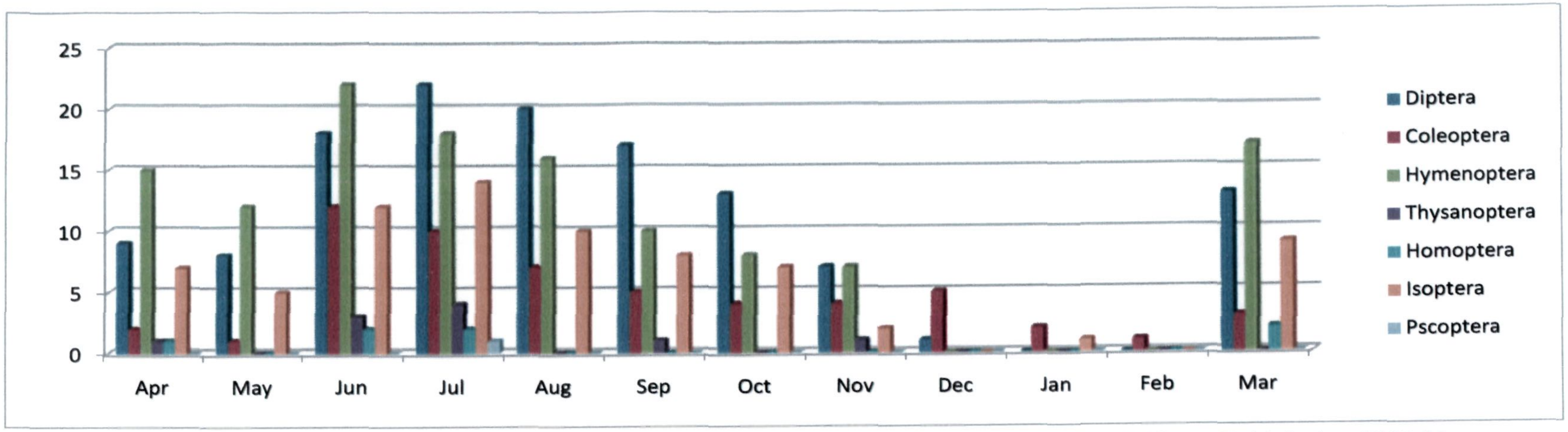


Figure 14c: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Wheat Field during 2008-09

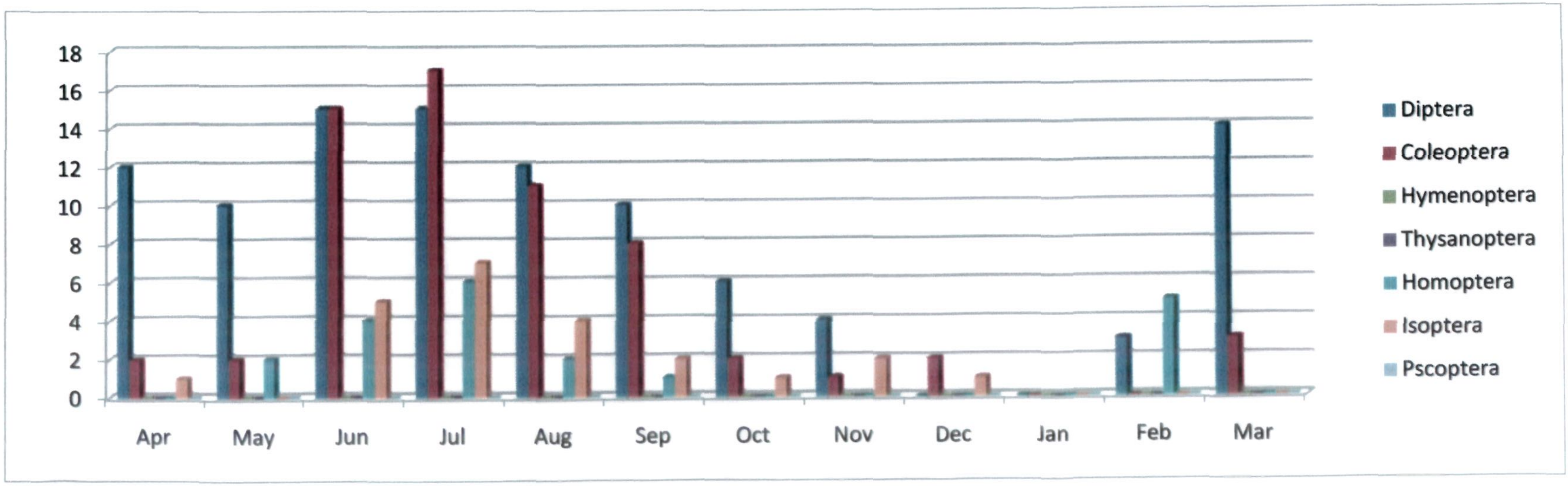


Figure 14d: Population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Wheat Field during 2008-09

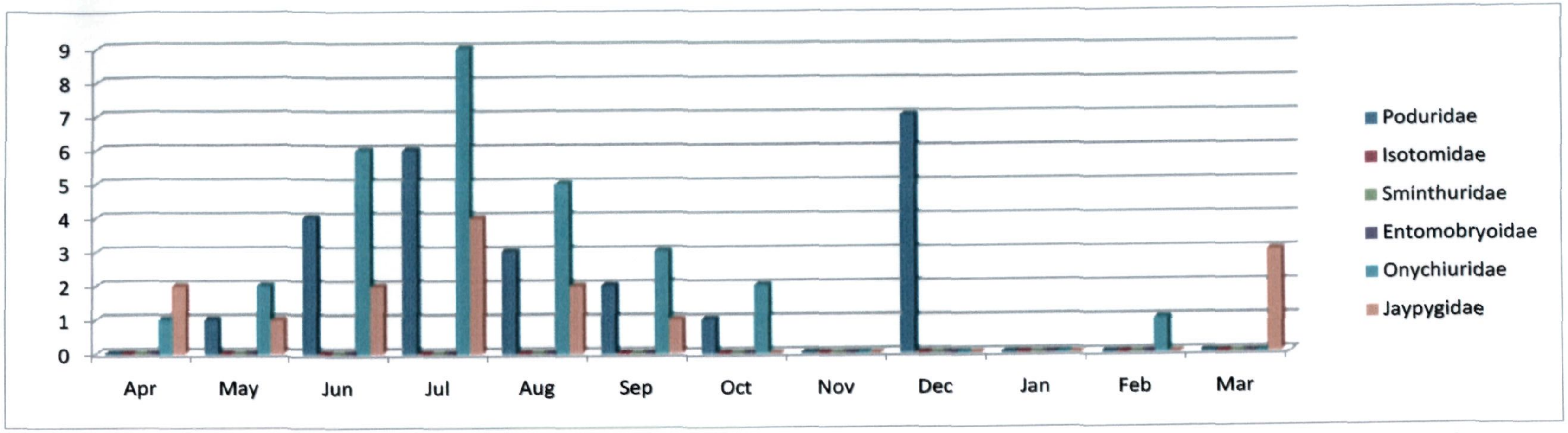


Figure 14e: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Wheat Field during 2008-09

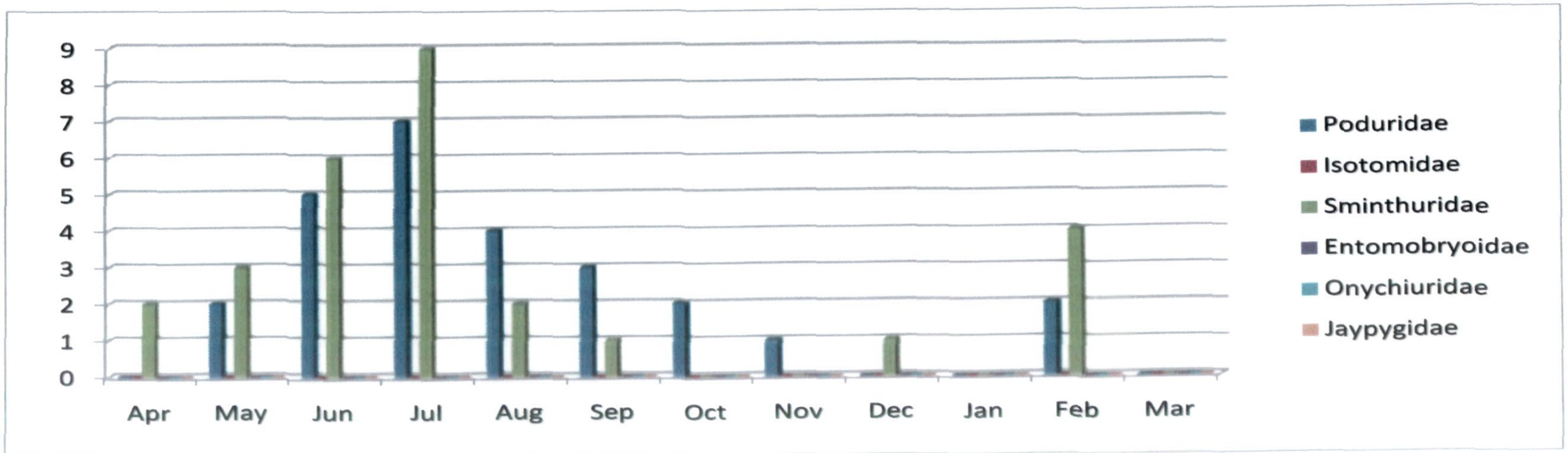


Figure 14f: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Wheat Field during 2008-09

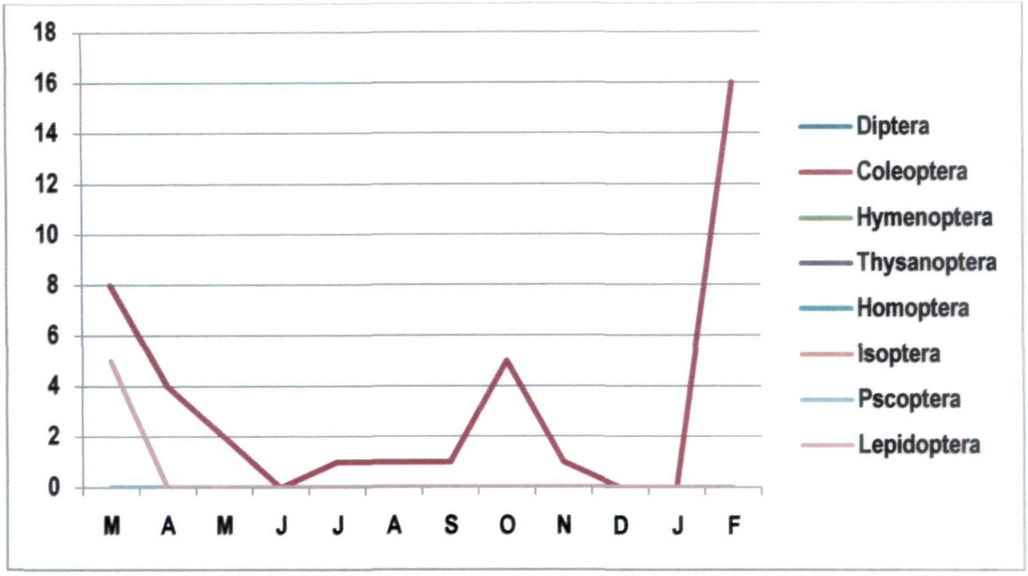


Figure 15a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2009-10

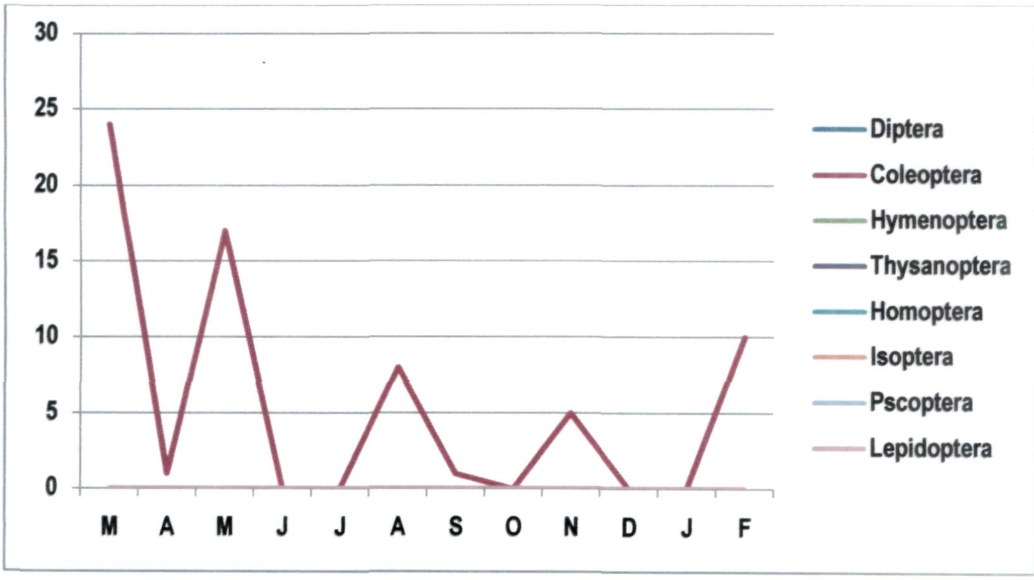


Figure 15b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Mango Orchards during 2009-10

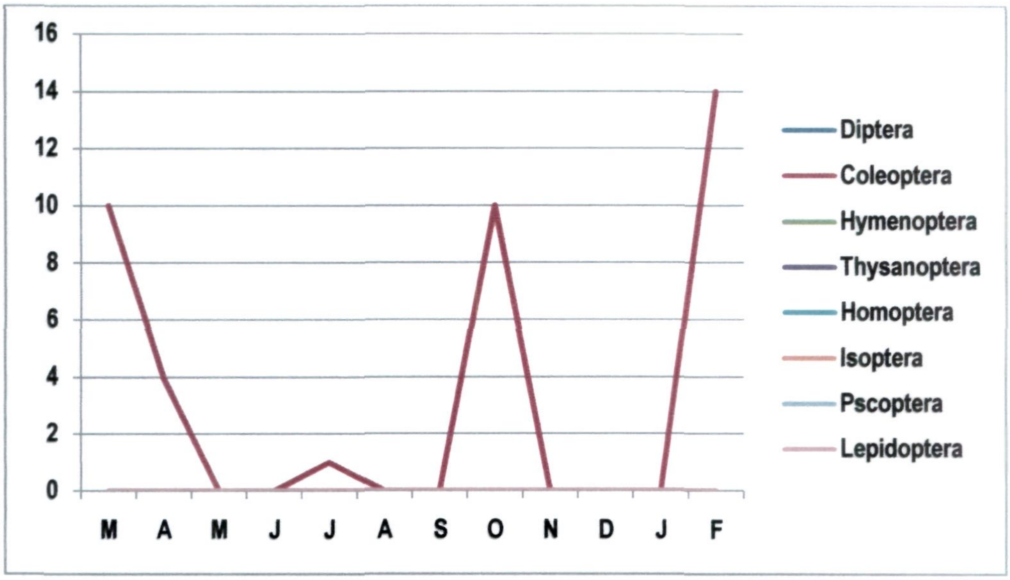


Figure 15c: Larval population fluctuation of Pterygote insects from the Litter at the site of Mango Orchards during 2009-10

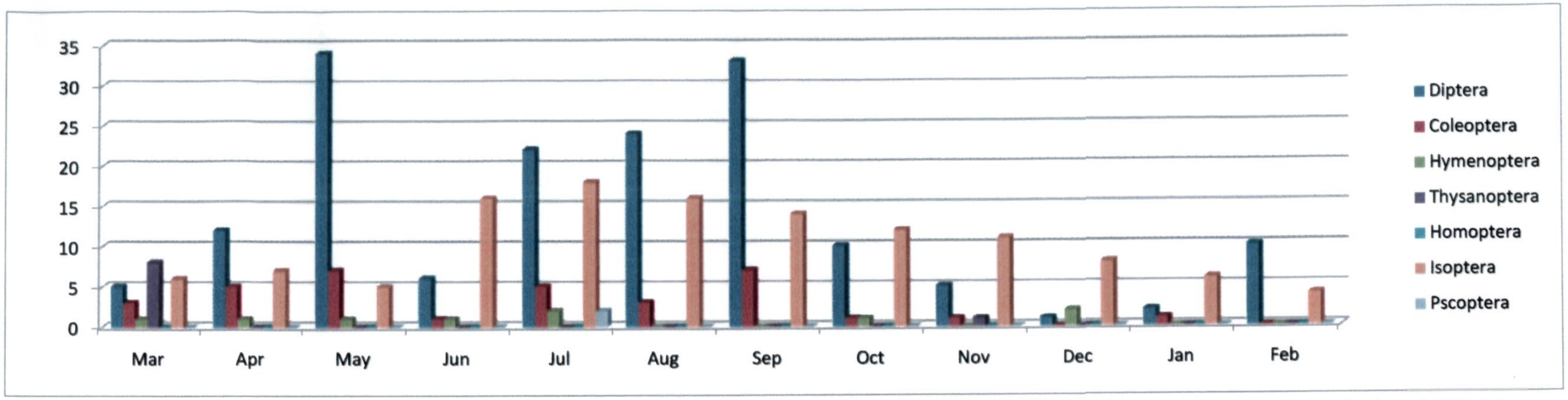


Figure 15d: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2009-10

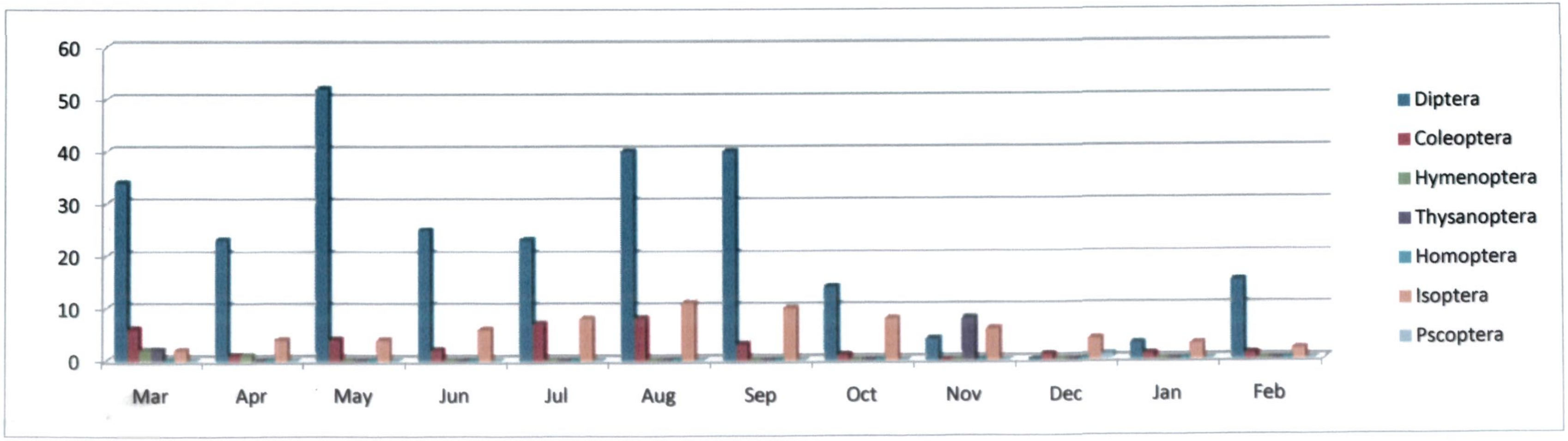


Figure 15e: Population fluctuation of Pterygote insects from the depth 5-10cm at the site of Mango Orchards during 2009-10

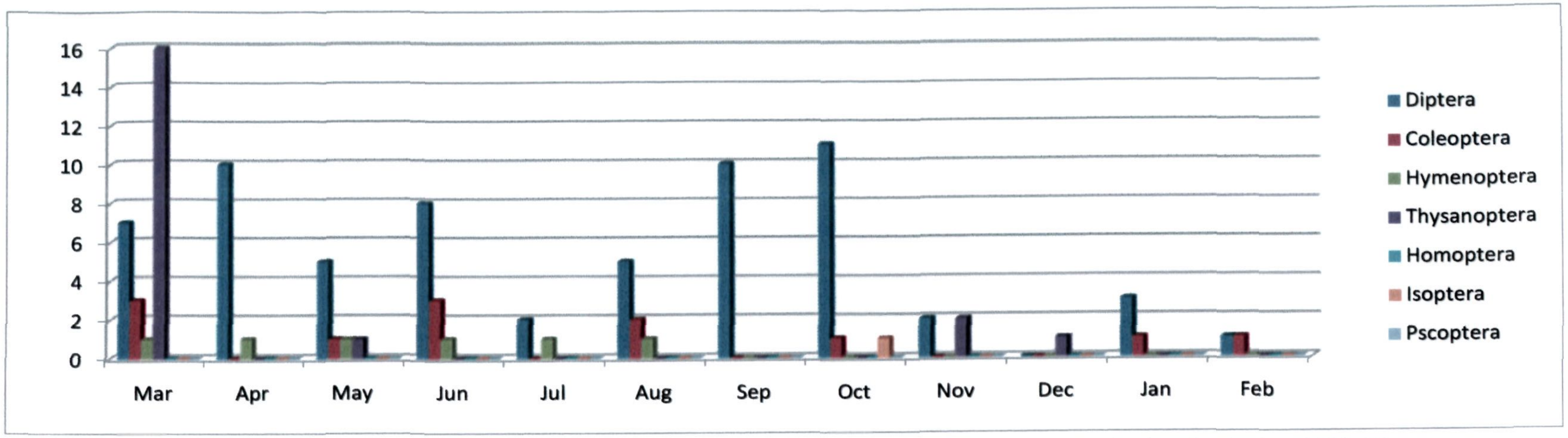


Figure 15f: Population fluctuation of Pterygote insects from the Litter at the site of Mango Orchards during 2009-10

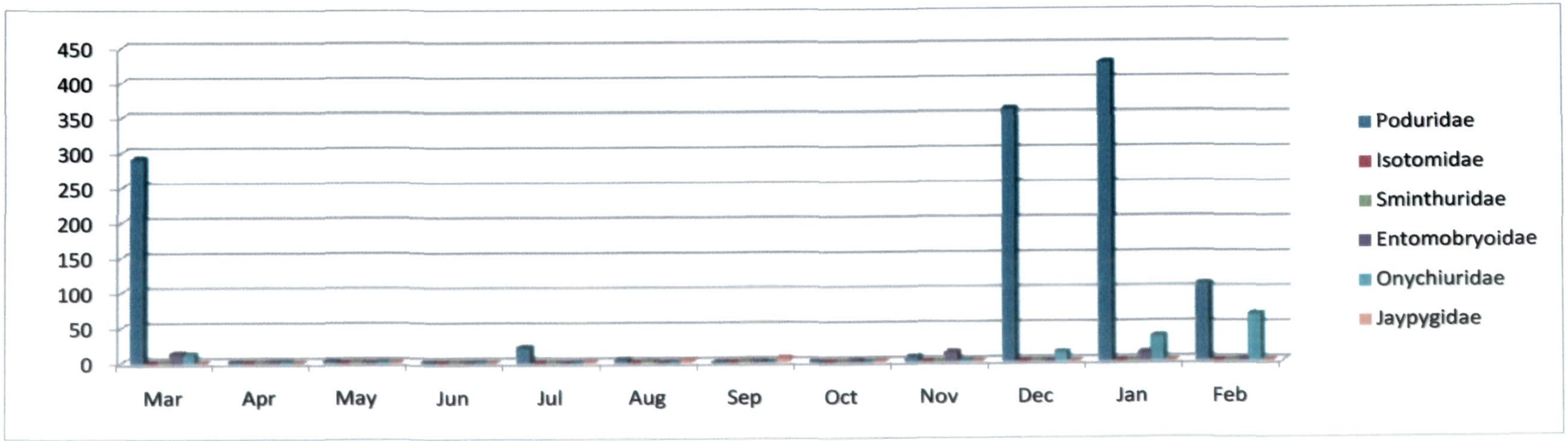


Figure 15g: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2009-10

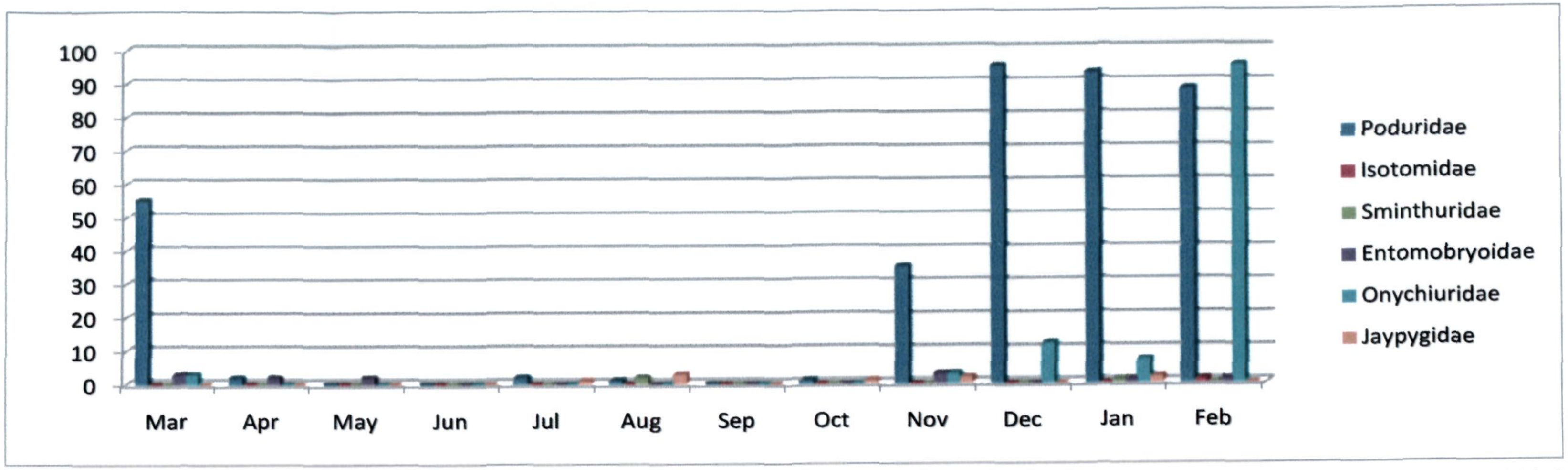


Figure 15h: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Mango Orchards during 2009-10

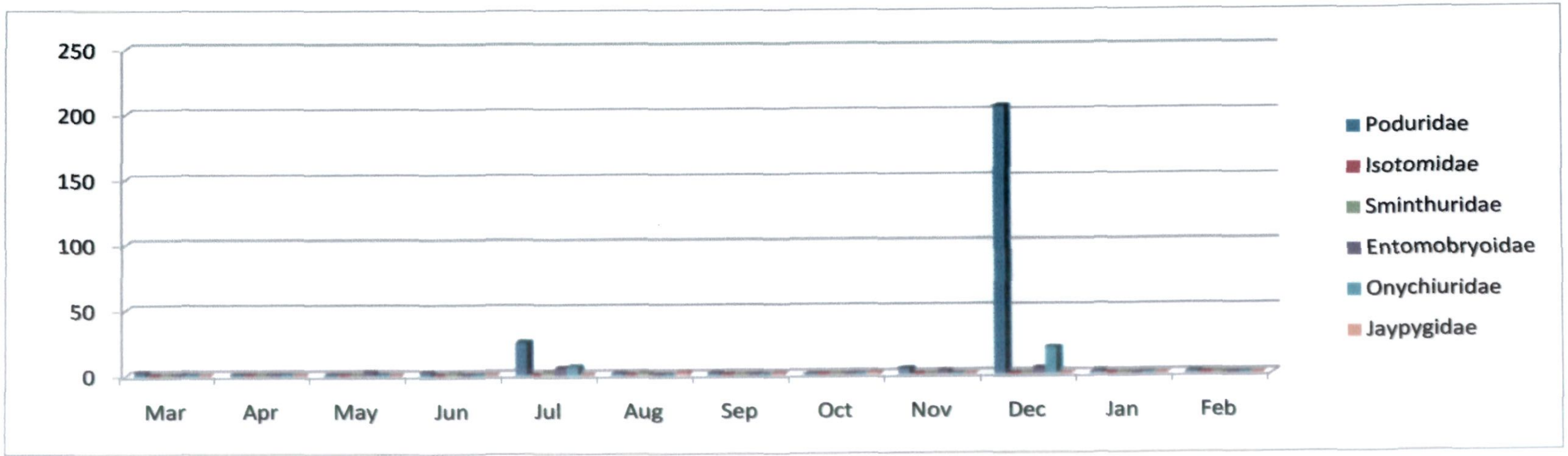


Figure 15i: Population fluctuation of Apterygote insects from the Litter at the site of Mango Orchards during 2009-10

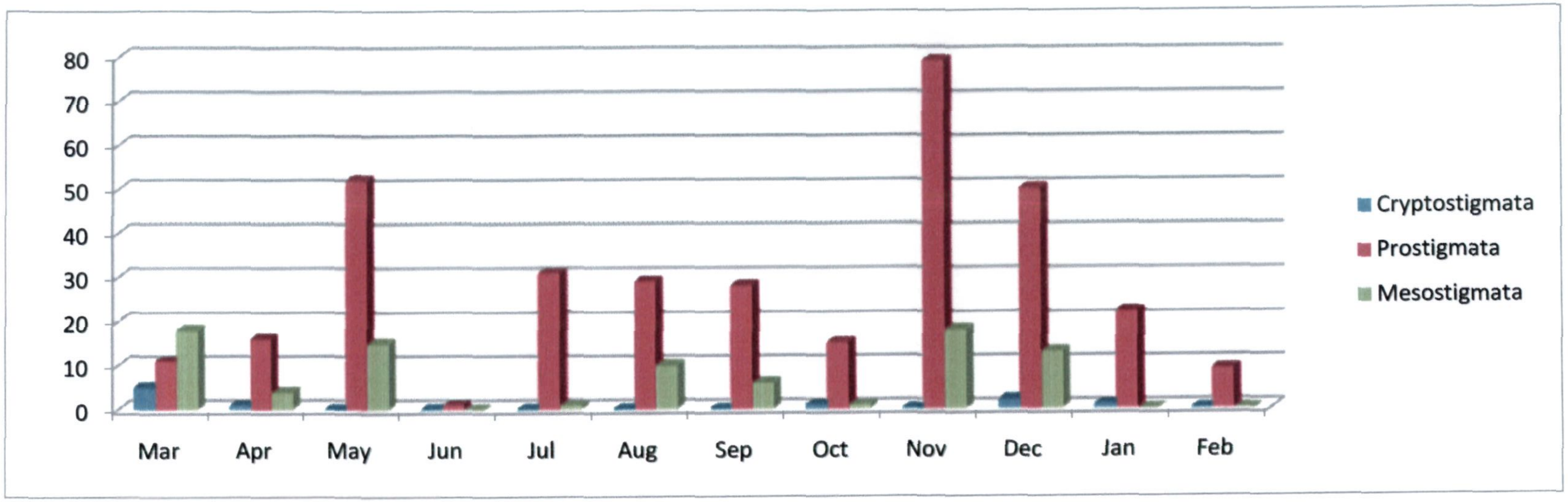


Figure 15j: Population fluctuation of Mites from the depth of 0-5cm at the site of Mango Orchards during 2009-10

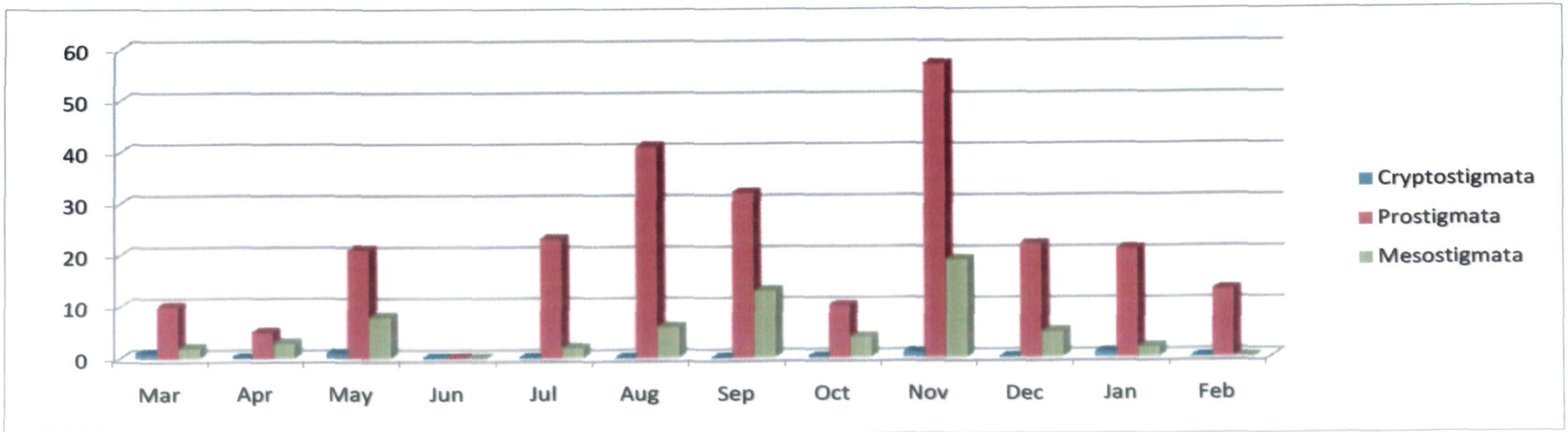


Figure 15k: Population fluctuation of Mites from the depth of 5-10cm at the site of Mango Orchards during 2009-10

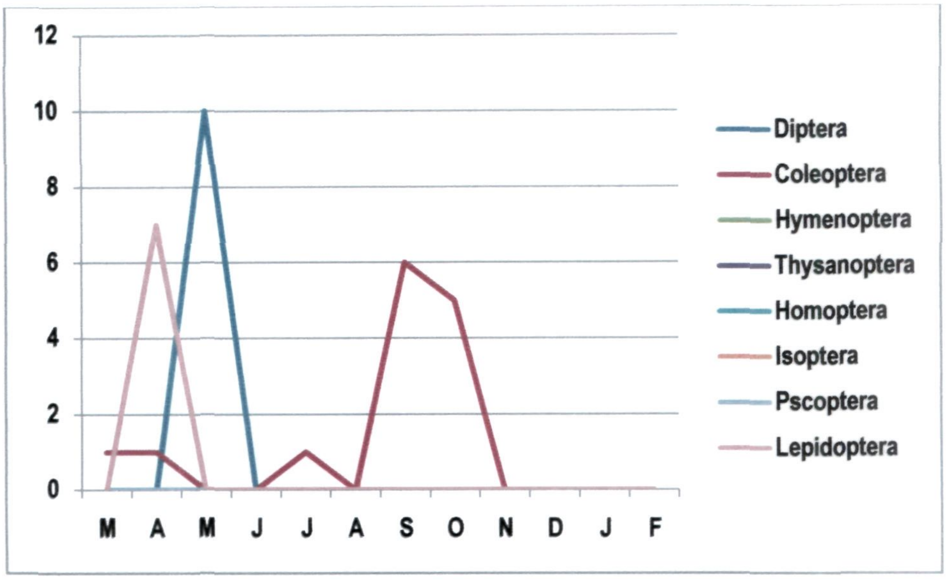


Figure 16a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2009-10

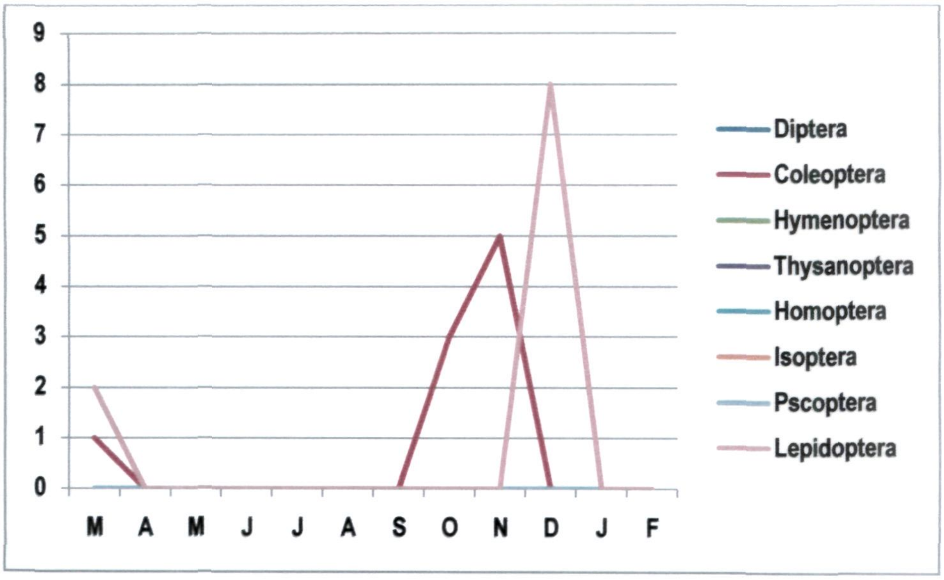


Figure 16b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2009-10

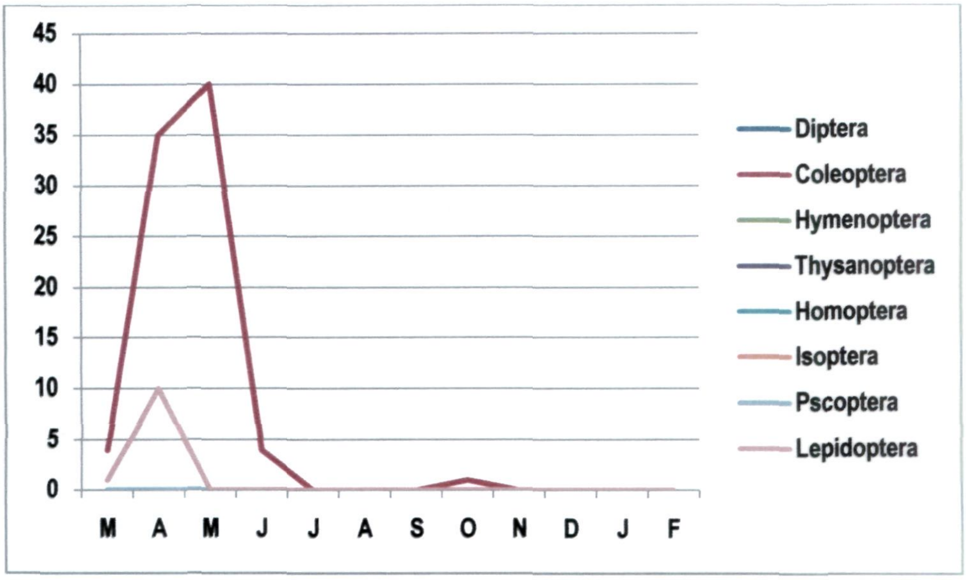


Figure 16c: Larval population fluctuation of Pterygote insects from the Litter at the site of Teak Plantation during 2009-10

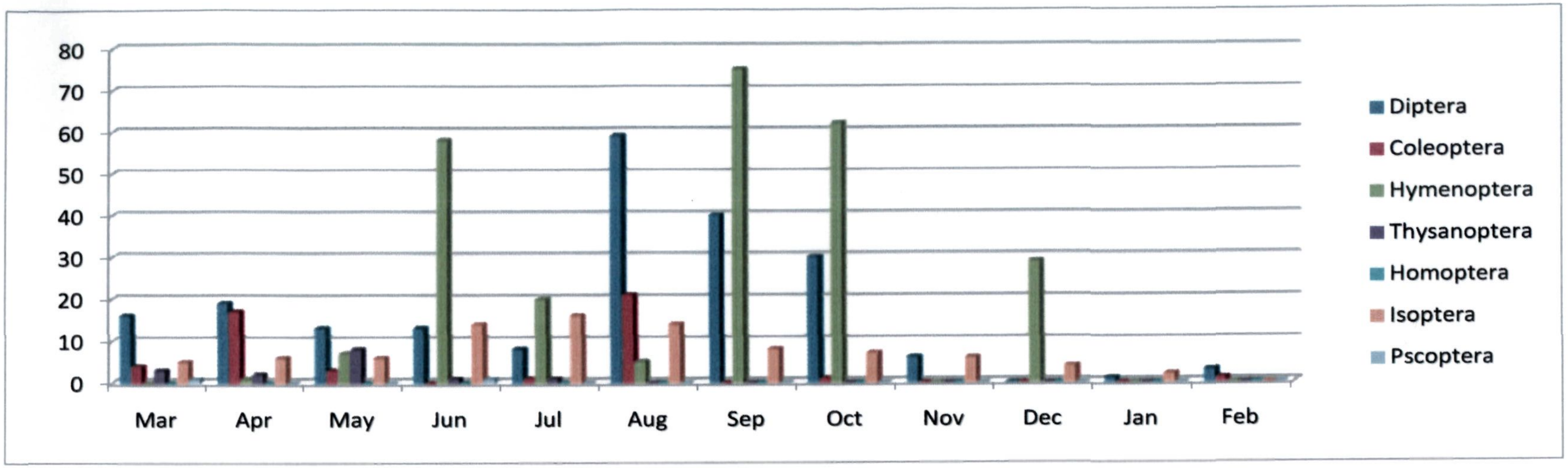


Figure 16d: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2009-10

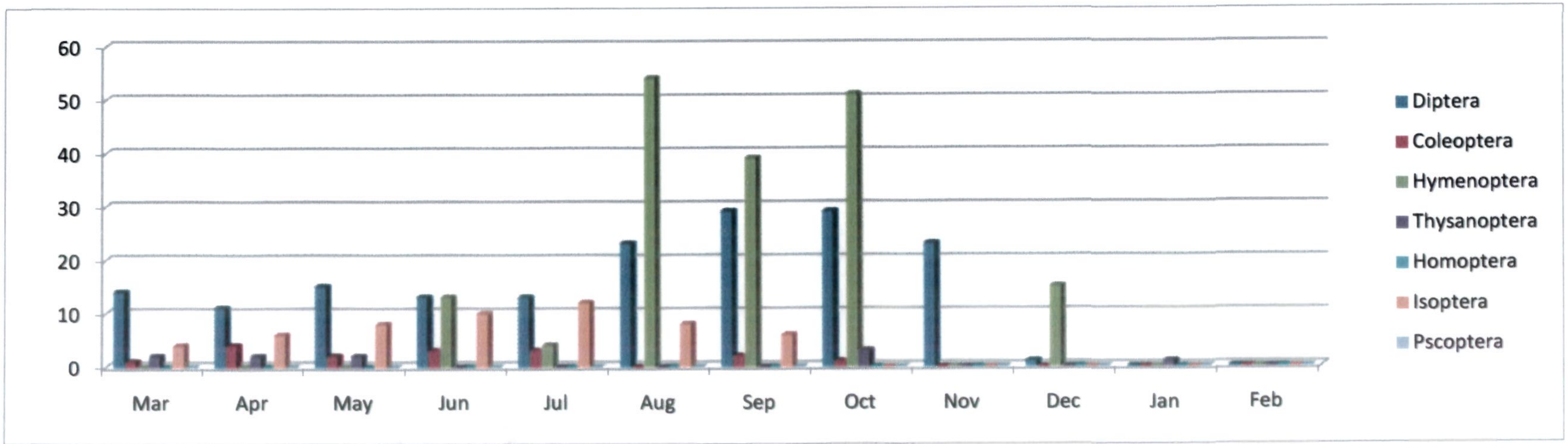


Figure 16e: Population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2009-10

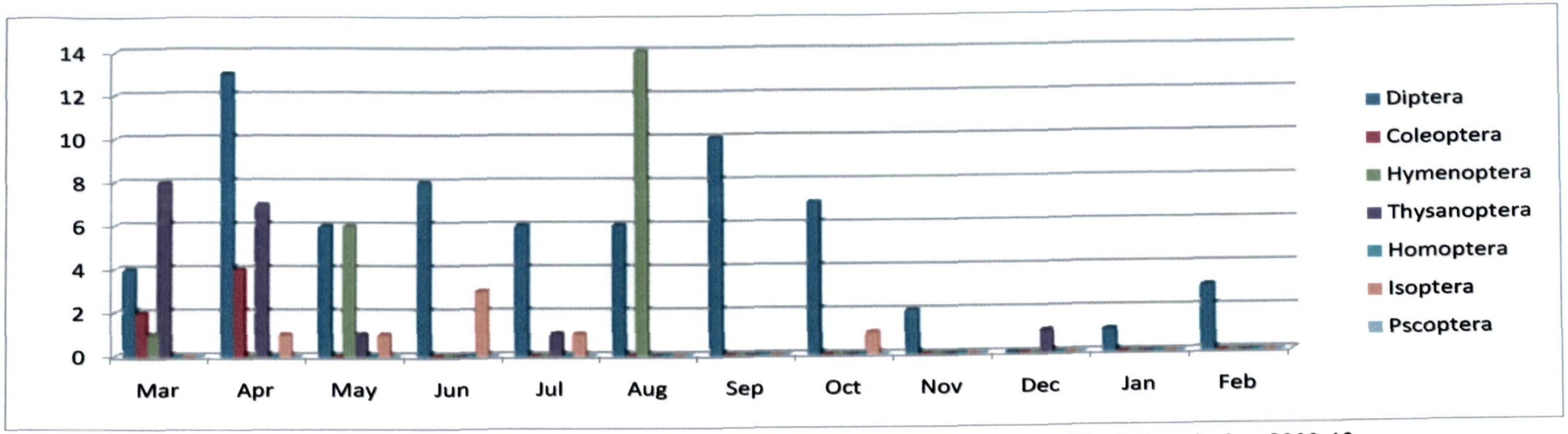


Figure 16f: Population fluctuation of Pterygote insects from the Litter at the site of Teak Plantation during 2009-10

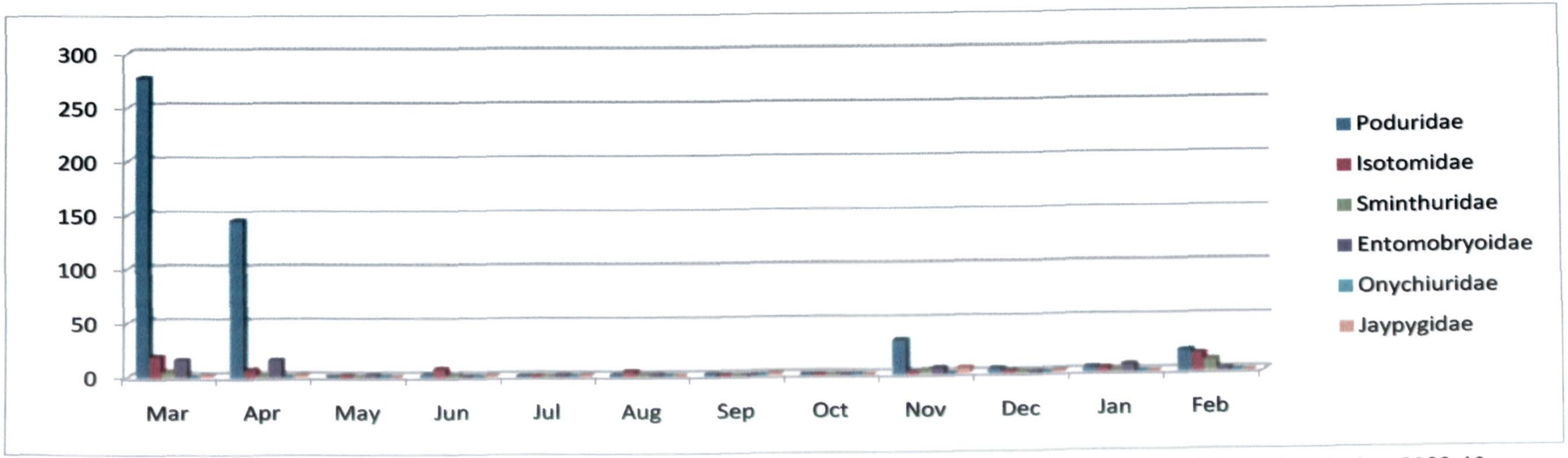


Figure 16g: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2009-10

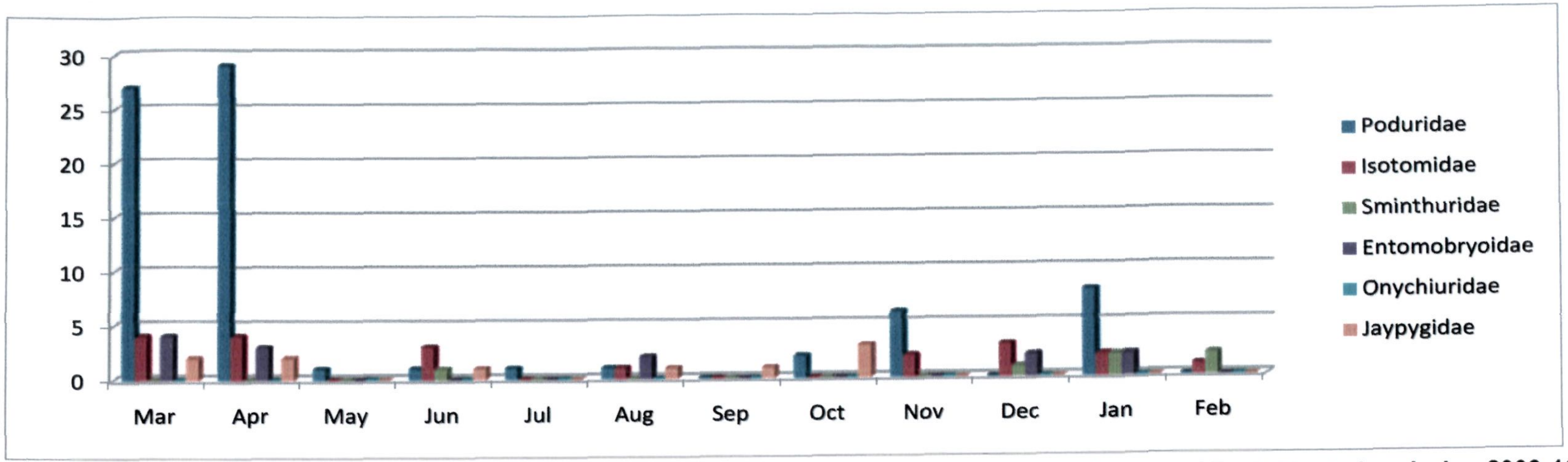


Figure 16h: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2009-10

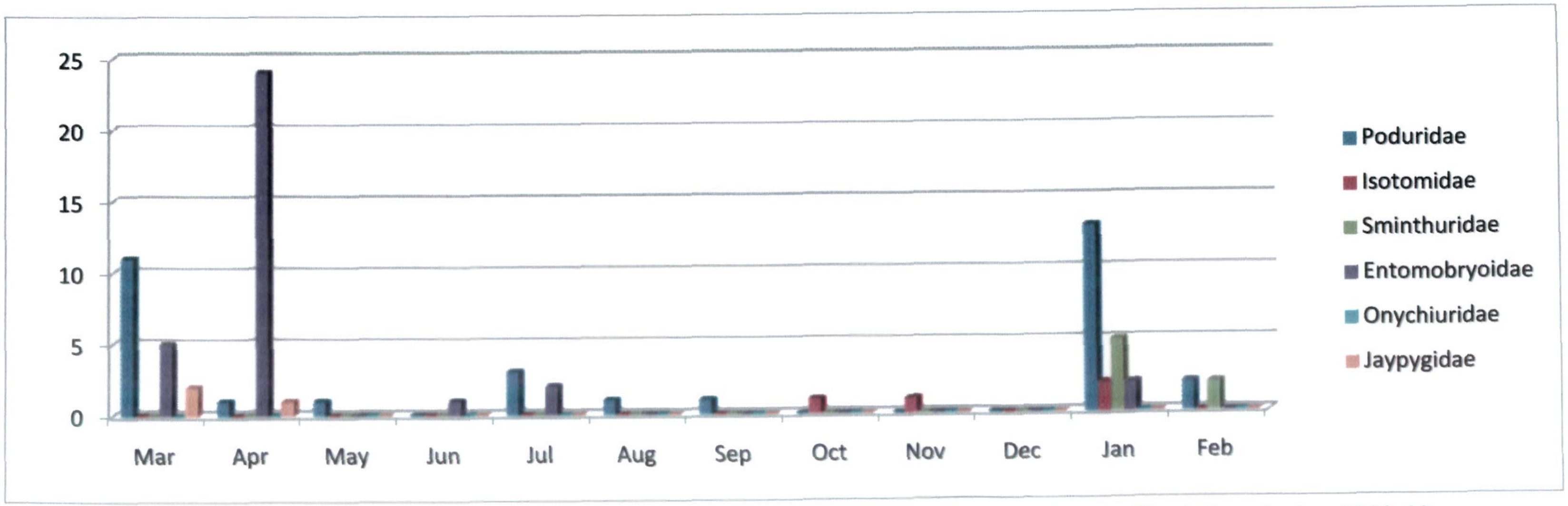


Figure 16i: Population fluctuation of Apterygote insects from the Litter at the site of Teak Plantation during 2009-10

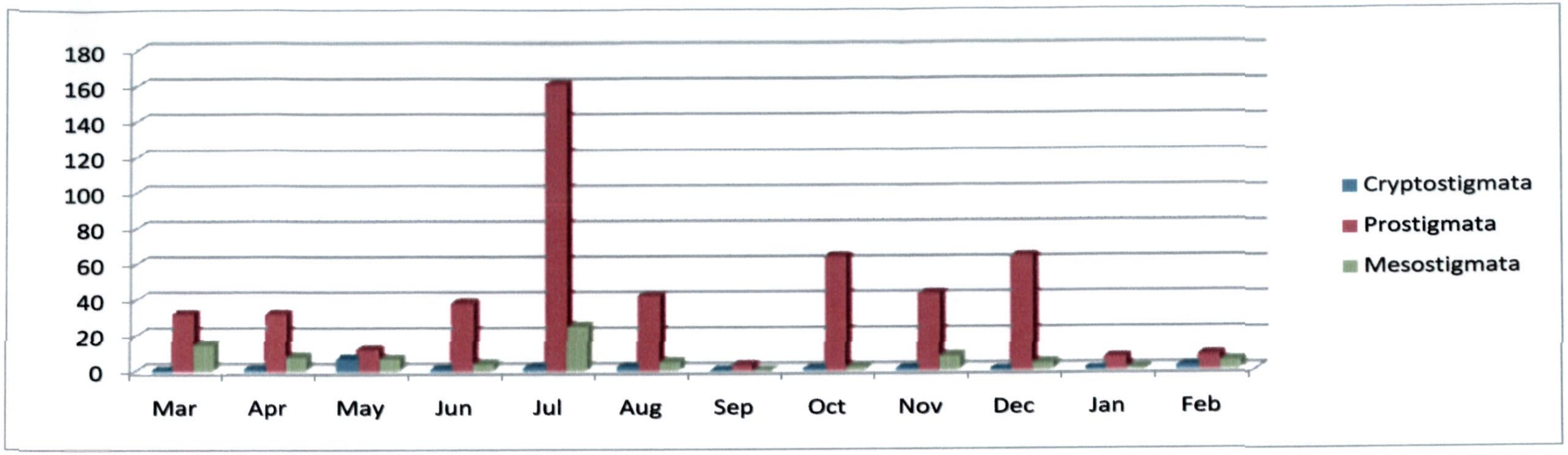


Figure 16j: Population fluctuation of Mites from the depth of 0-5cm at the site of Teak Plantation during 2009-10

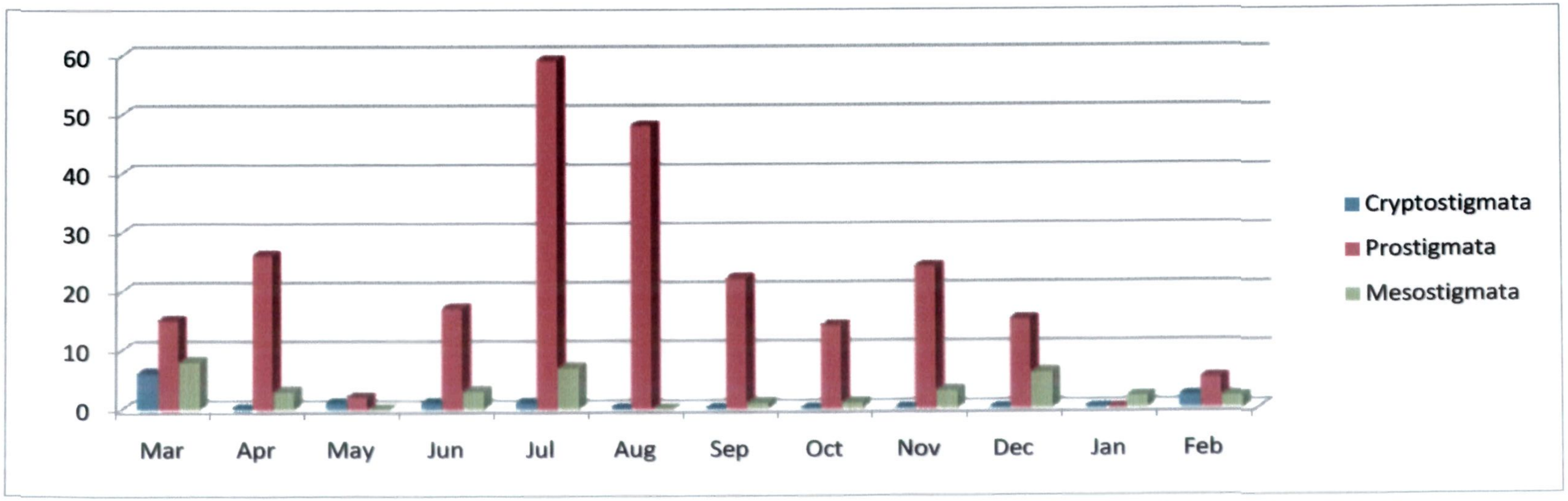


Figure 16k: Population fluctuation of Mites from the depth of 5-10cm at the site of Teak Plantation during 2009-10

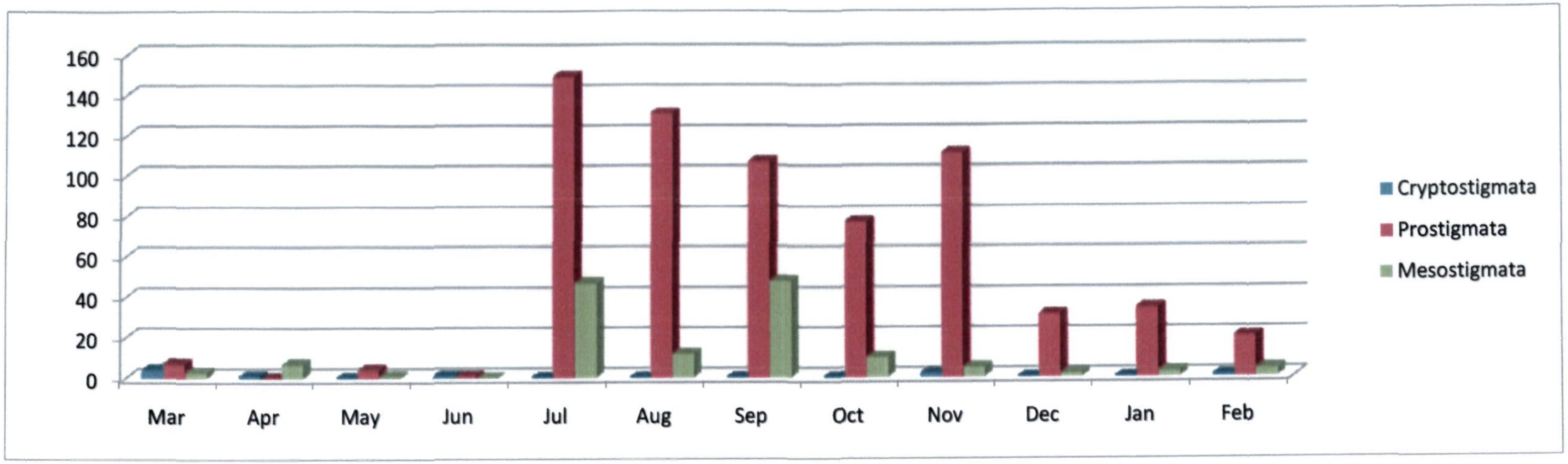


Figure 16l: Population fluctuation of Mites from the Litter at the site of Teak Plantation during 2009-10

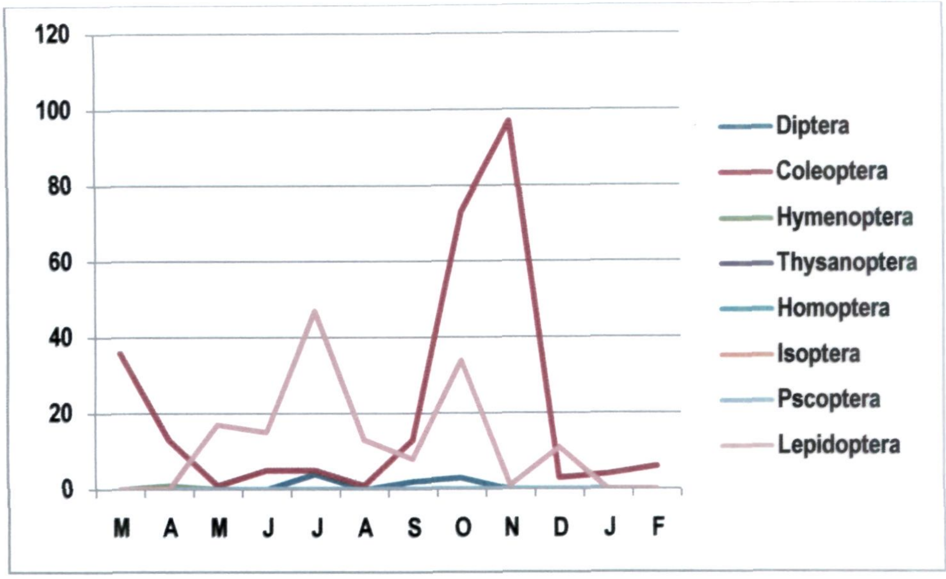


Figure 17a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Unarable Land during 2009-10

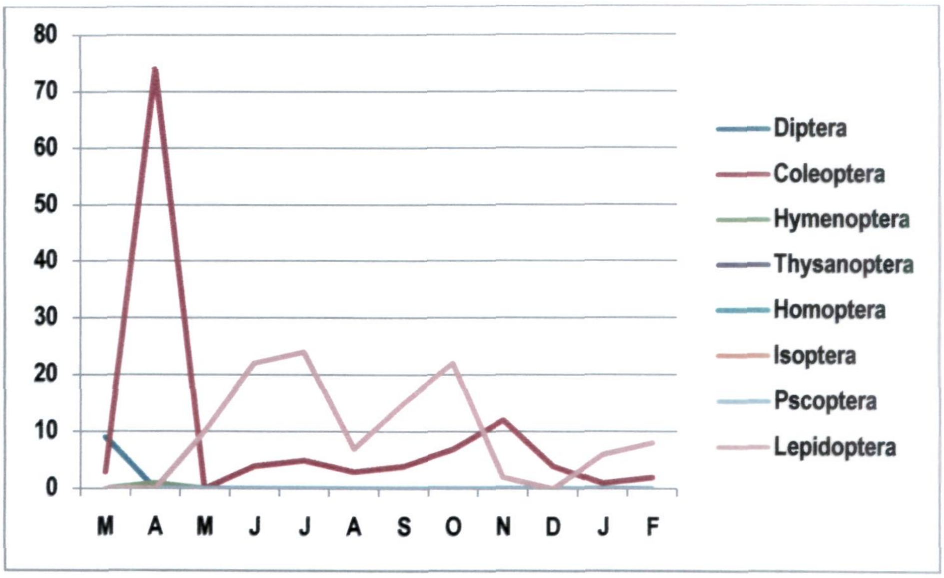


Figure 17b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Unarable Land during 2009-10

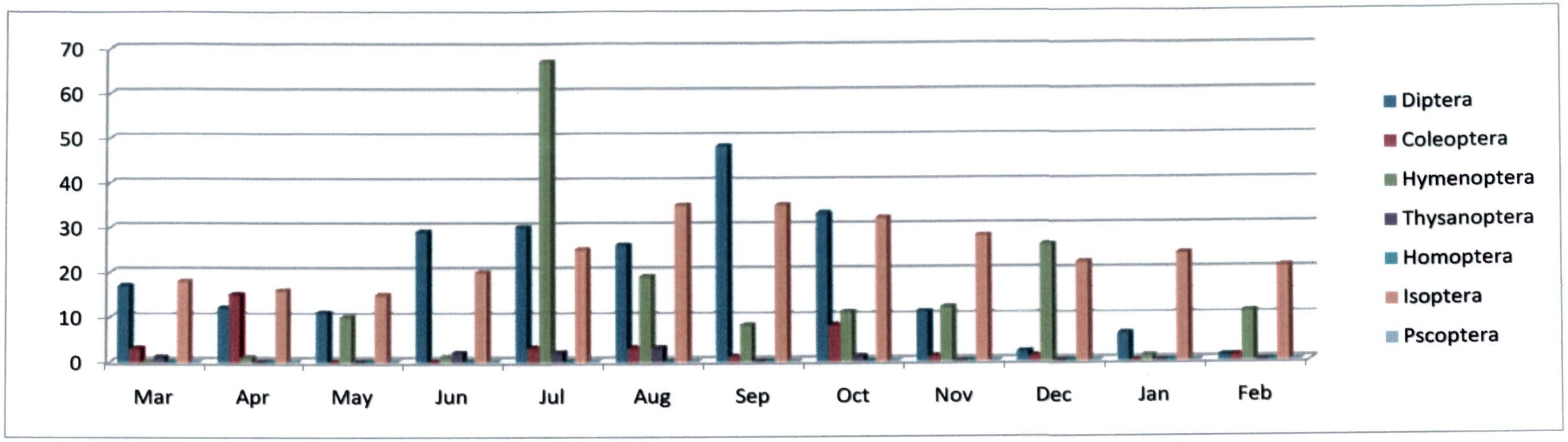


Figure 17c: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Unarable Land during 2009-10

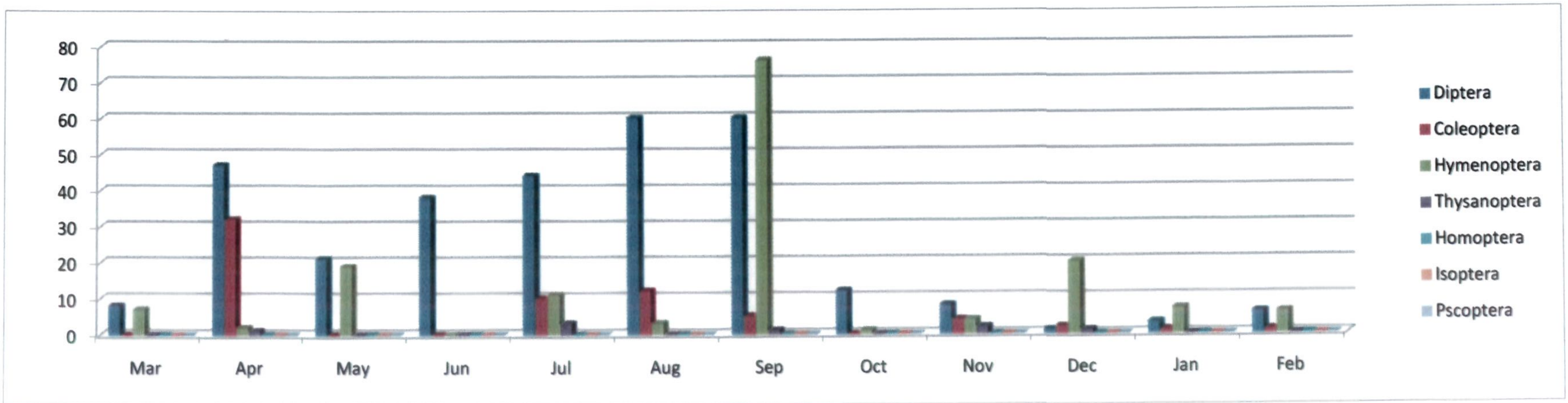


Figure 17d: Population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Unarable Land during 2009-10

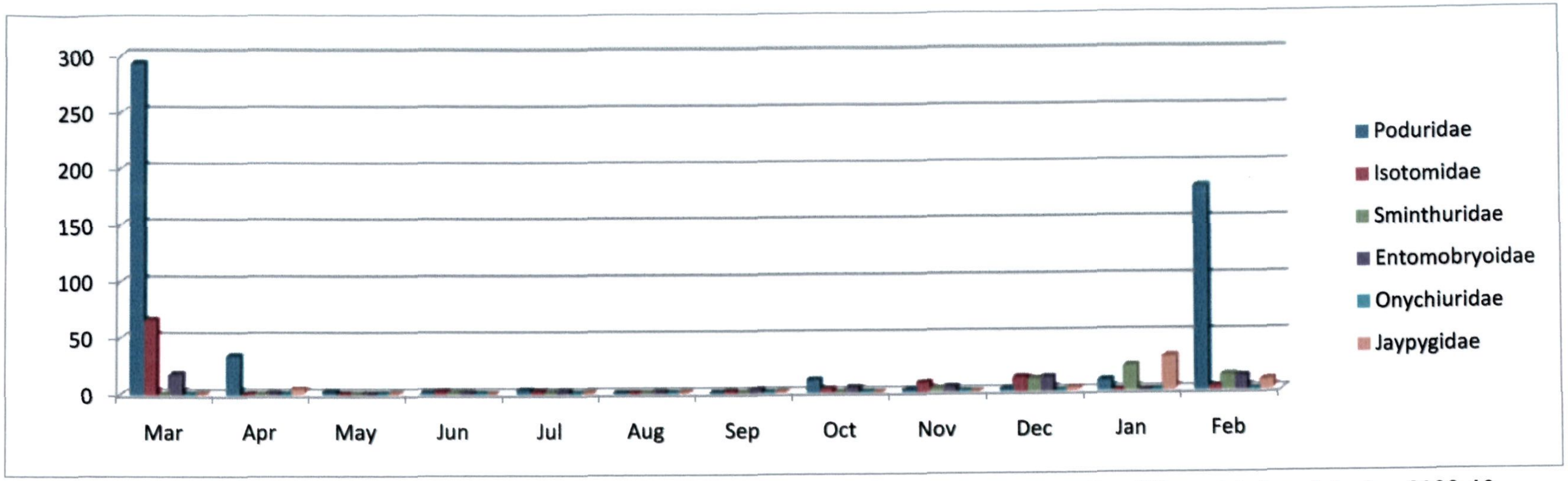


Figure 17e: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Unarable Land during 2009-10

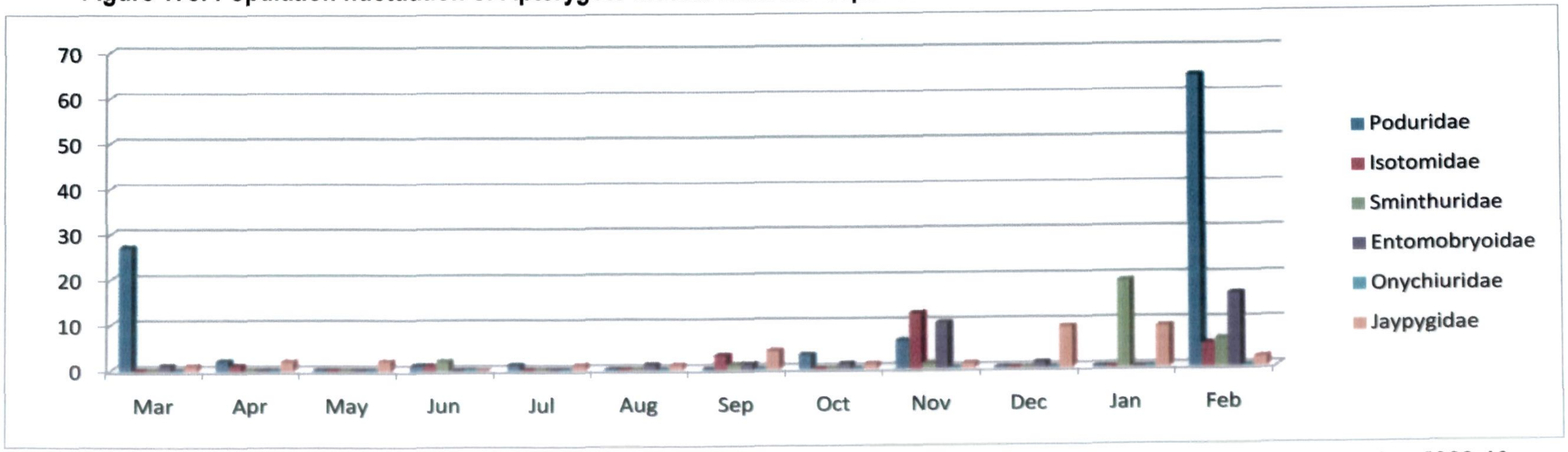


Figure 17f: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Unarable Land during 2009-10

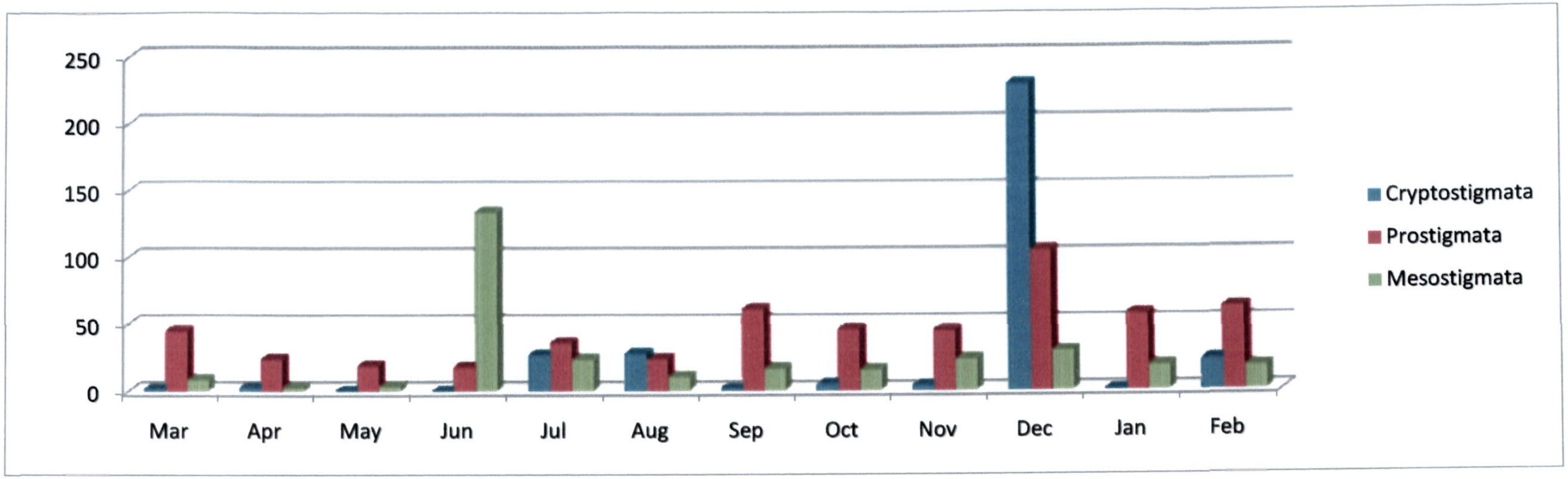


Figure 17g: Population fluctuation of Mites from the depth of 0-5cm at the site of Unarable Land during 2009-10

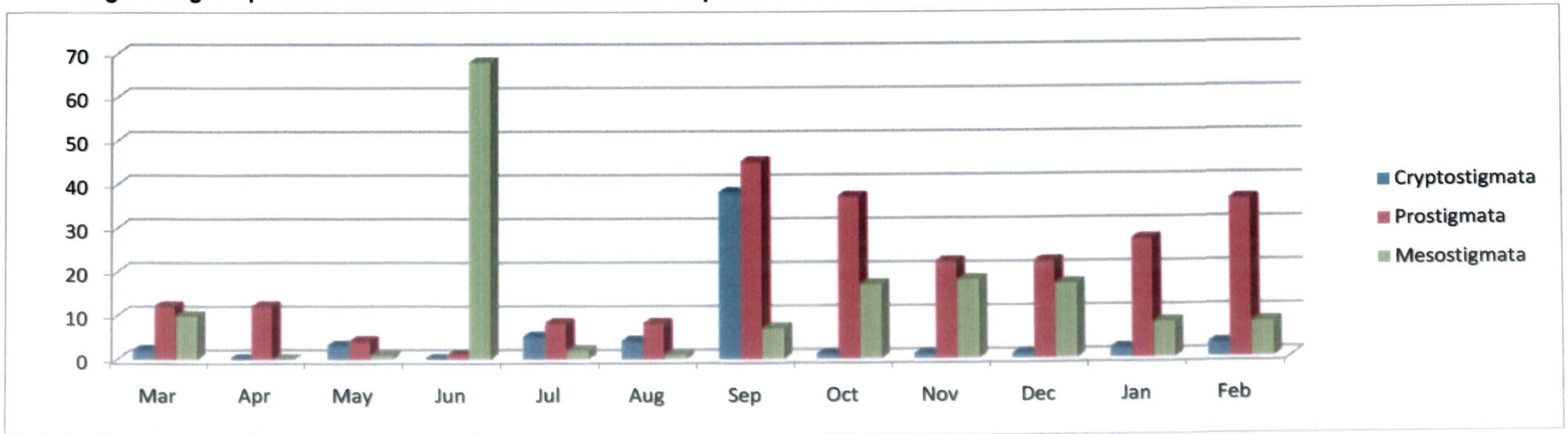


Figure 17h: Population fluctuation of Mites from the depth of 5-10cm at the site of Unarable Land during 2009-10

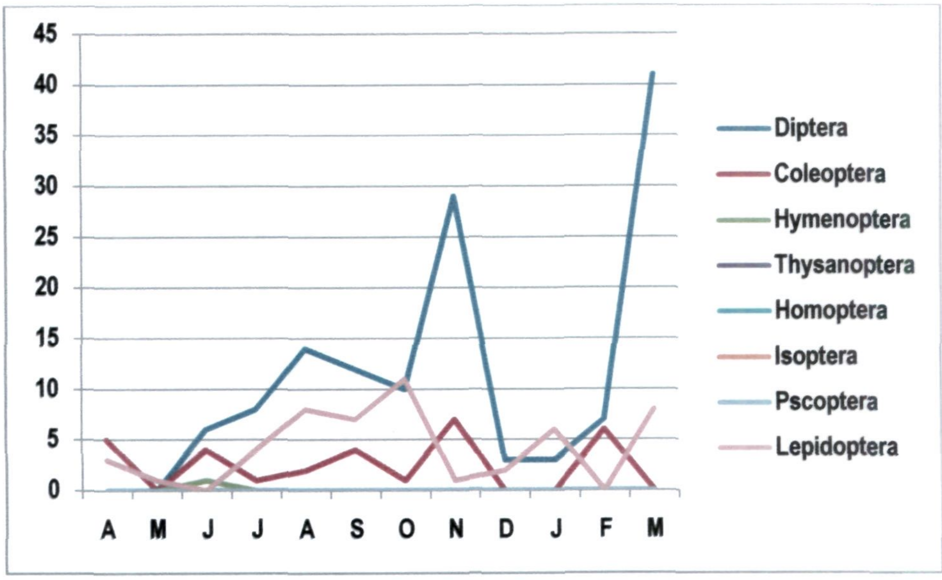


Figure 18a: Larval population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Wheat Field during 2009-10

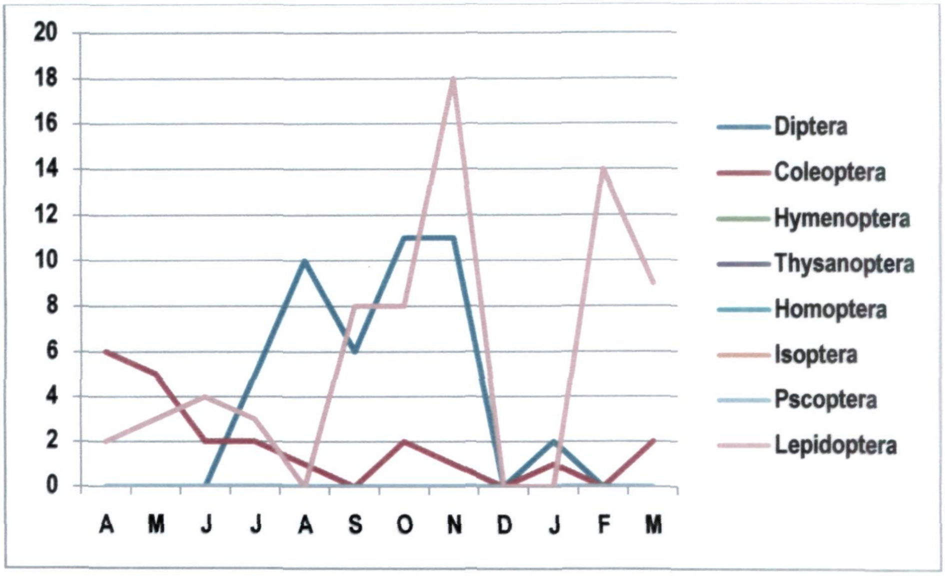


Figure 18b: Larval population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Wheat Field during 2009-10

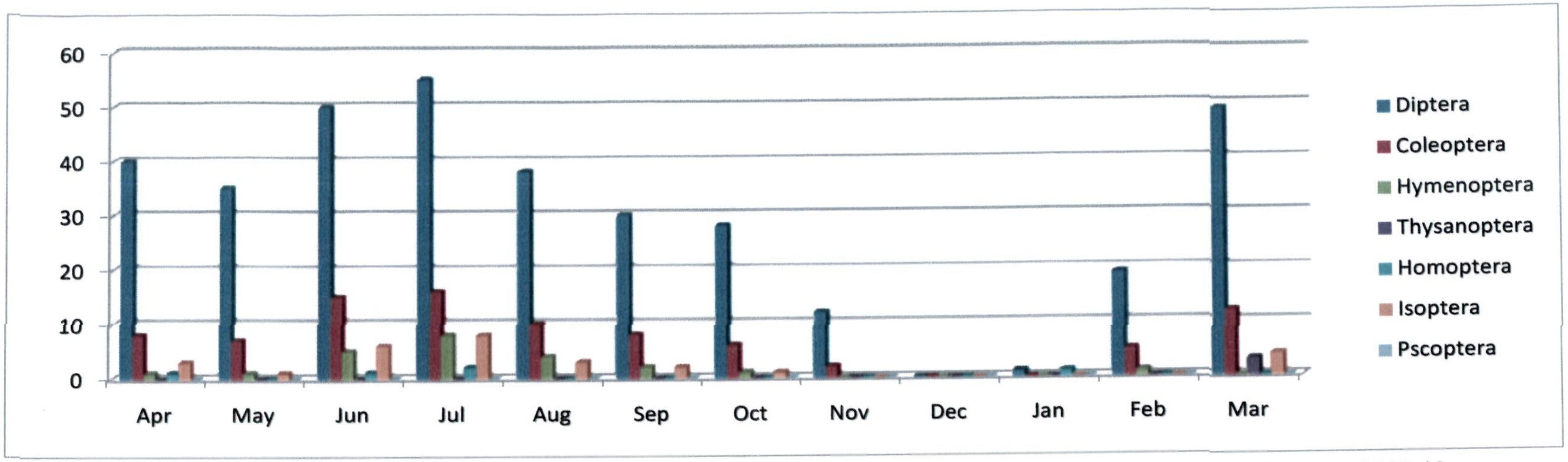


Figure 18c: Population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Wheat Field during 2009-10

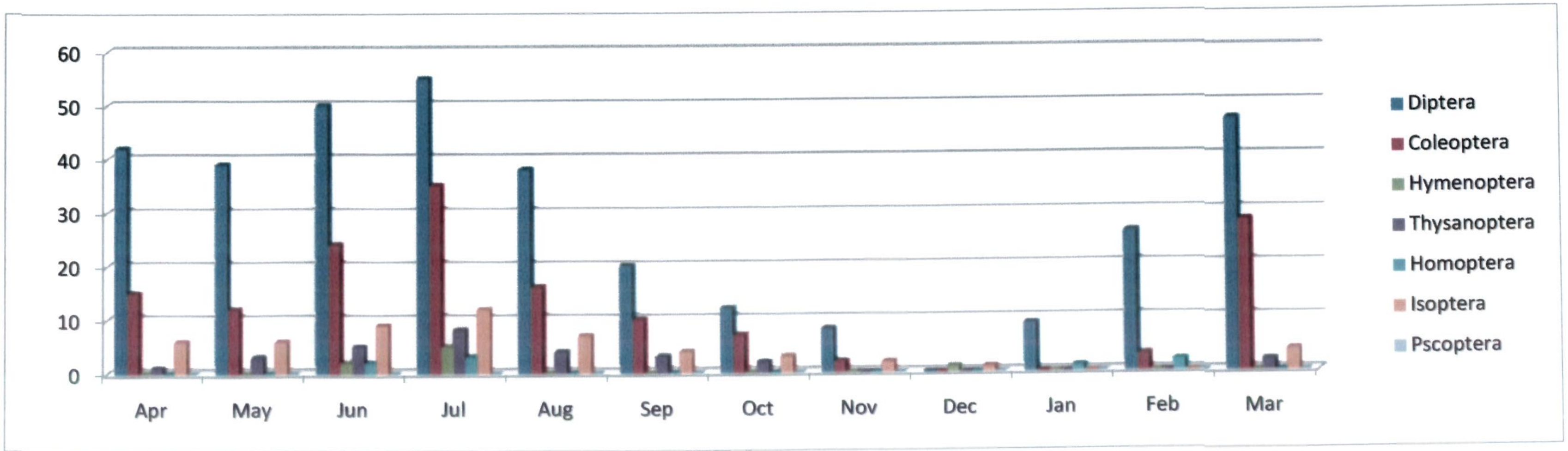


Figure 18d: Population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Wheat Field during 2009-10

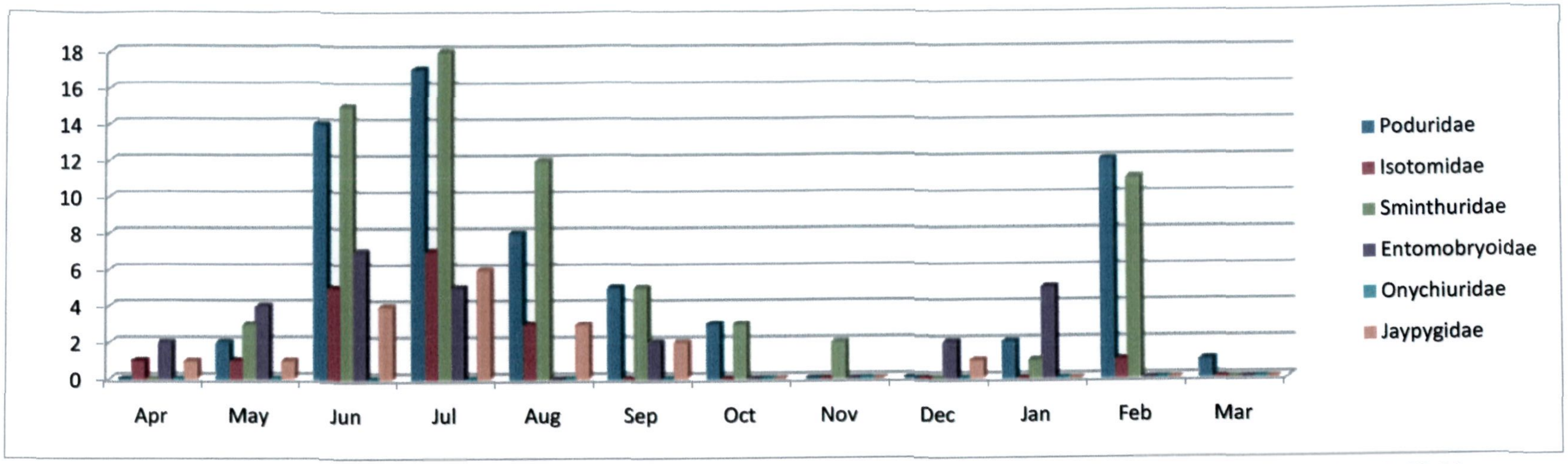


Figure 18e: Population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Wheat Field during 2009-10

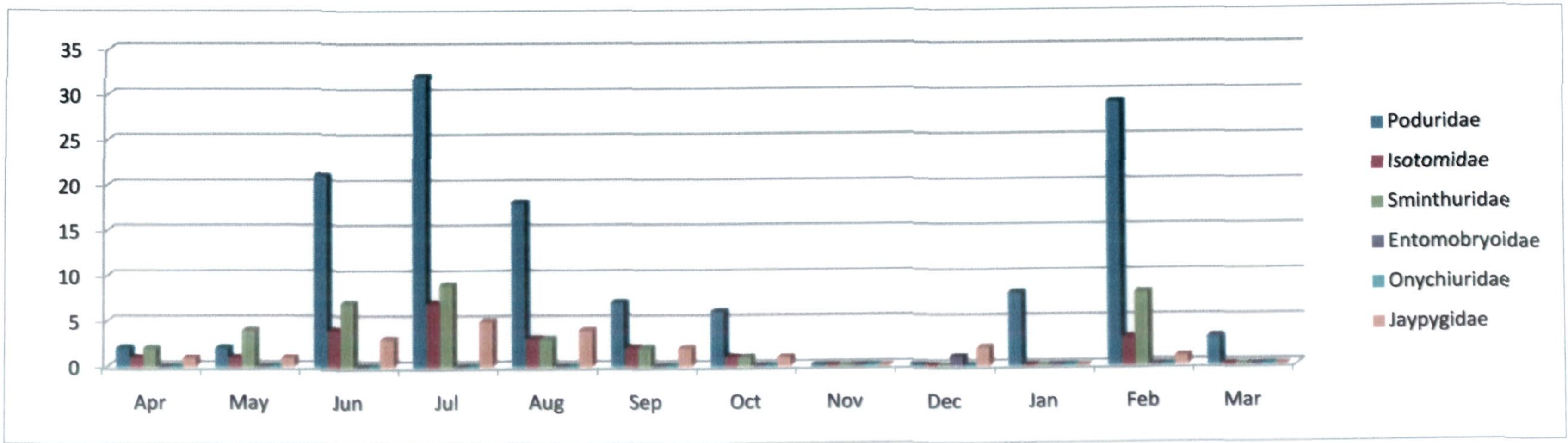


Figure 18f: Population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Wheat Field during 2009-10

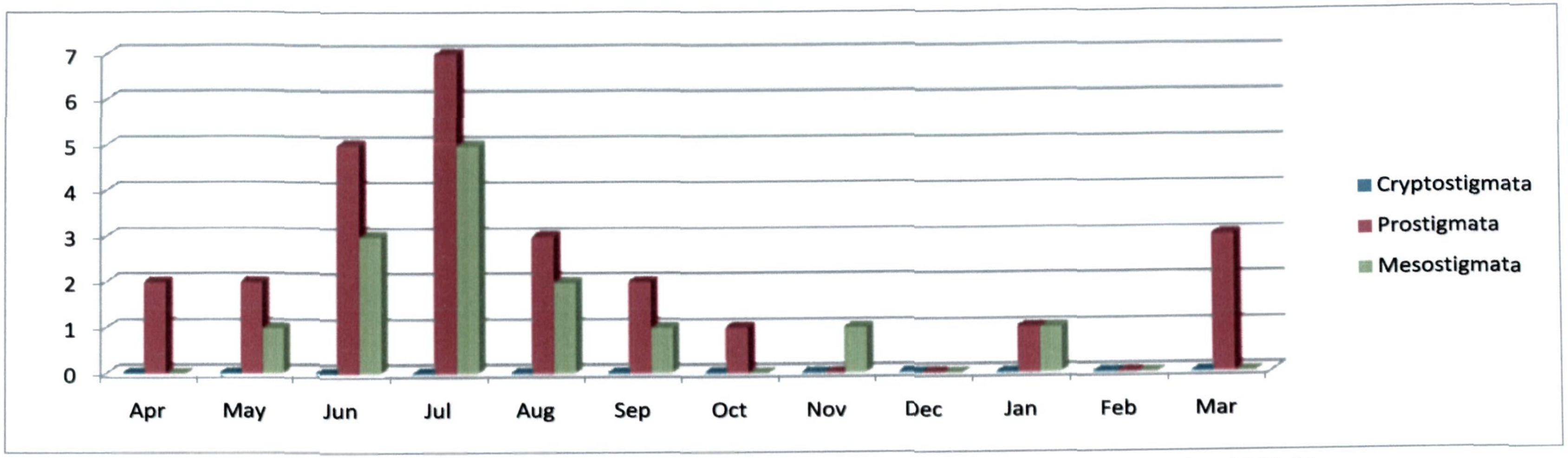


Figure 18g: Population fluctuation of Mites from the depth of 0-5cm at the site of Wheat Field during 2009-10

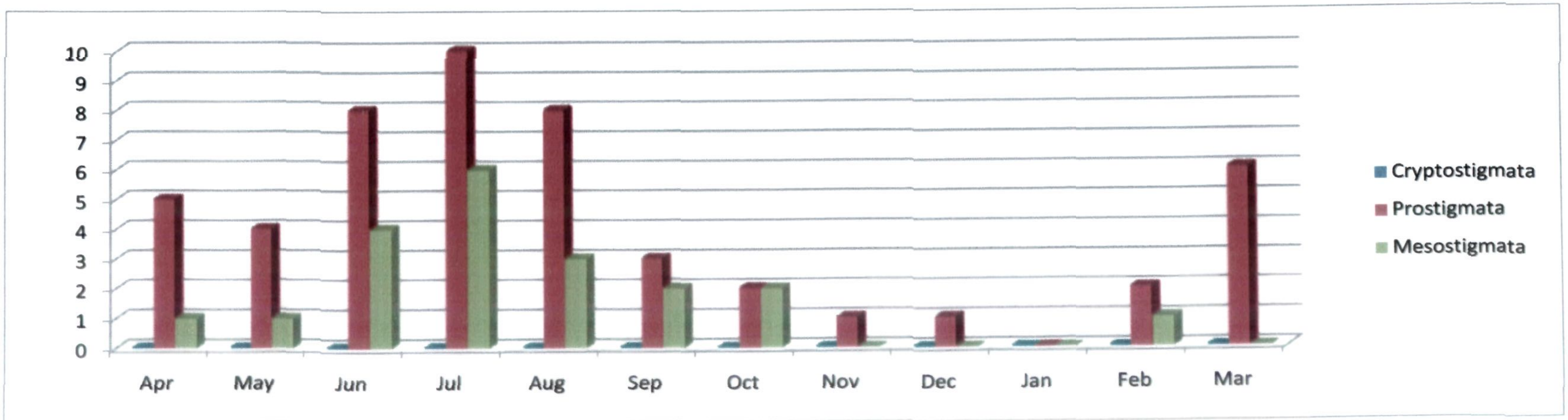


Figure 18h: Population fluctuation of Mites from the depth of 5-10cm at the site of Wheat Field during 2009-10

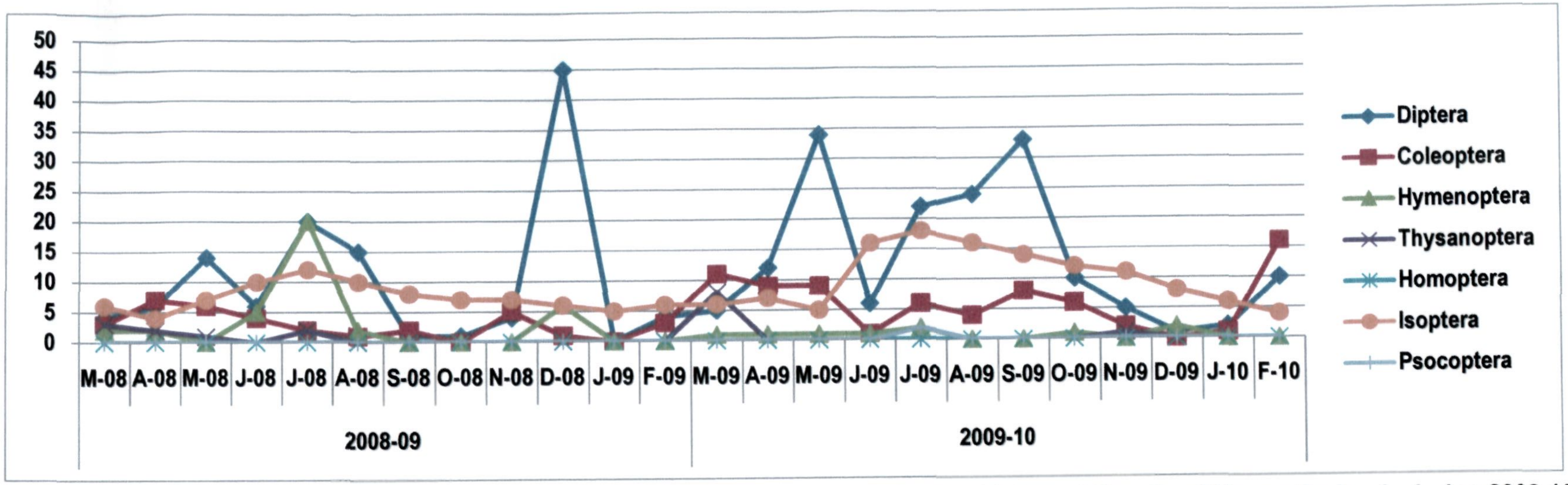


Figure 19a:Comparison of population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2008-10

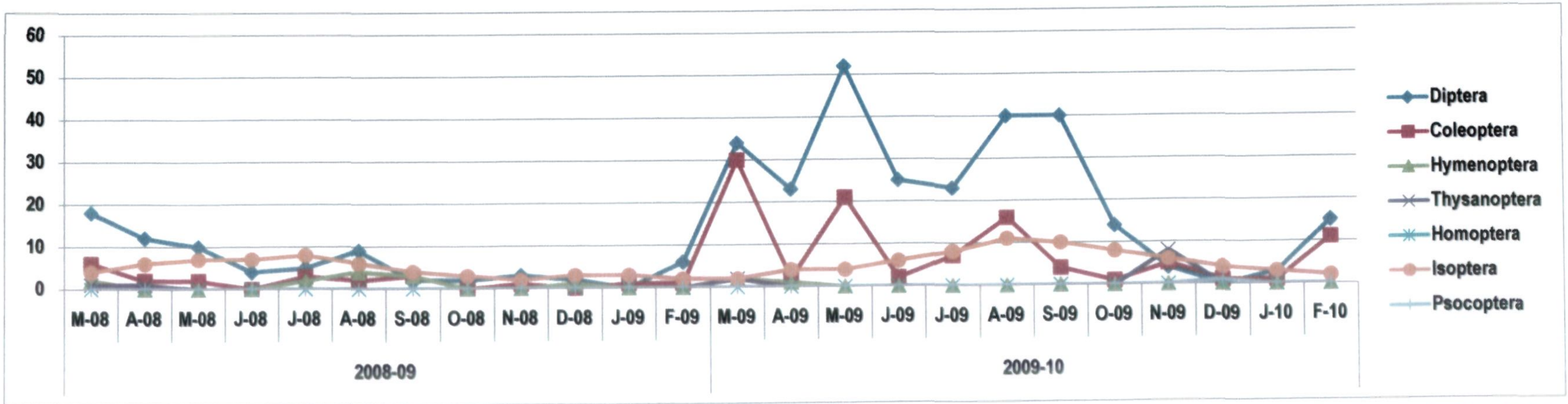


Figure 19b:Comparison of population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Mango Orchards during 2008-10

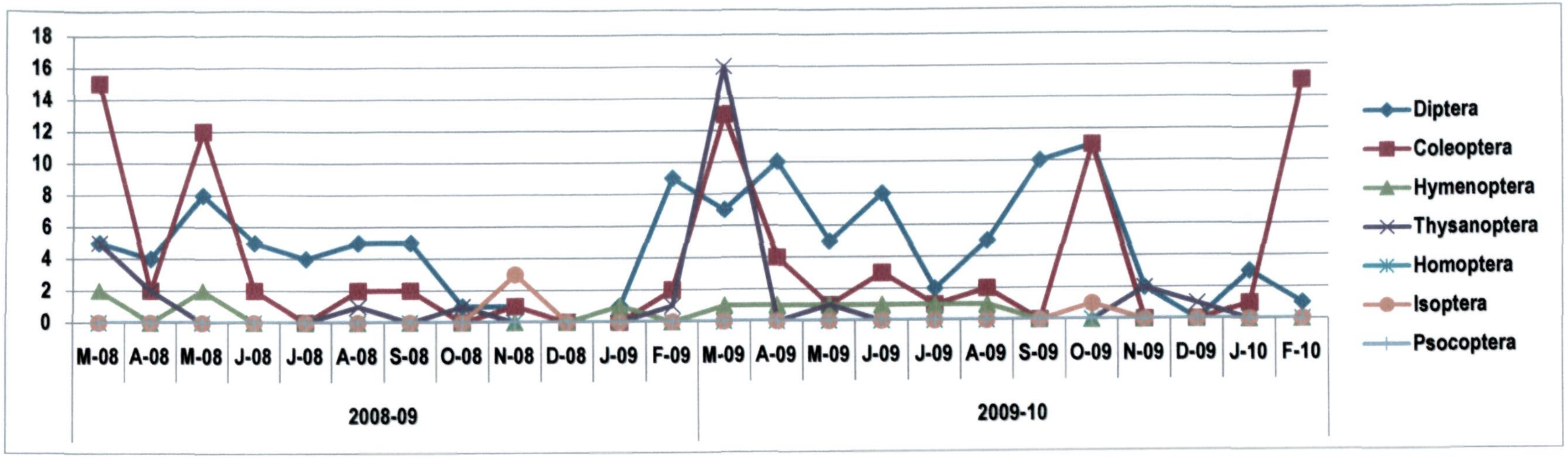


Figure 19c: Comparison of population fluctuation of Pterygote insects from the Litter at the site of Mango Orchards during 2008-10

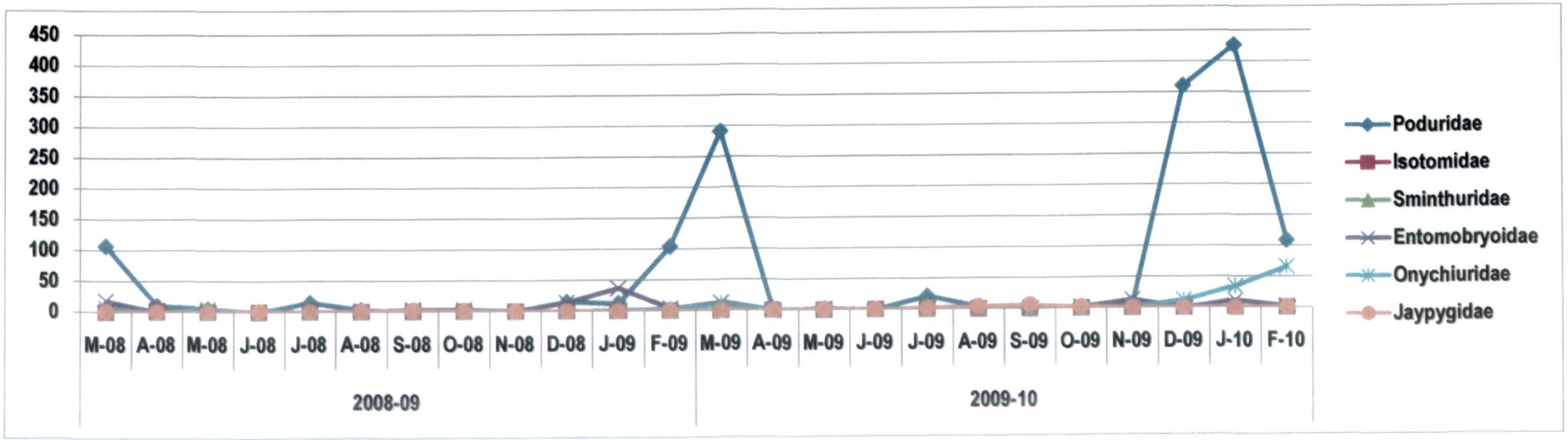


Figure 19d:Comparison of population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Mango Orchards during 2008-10

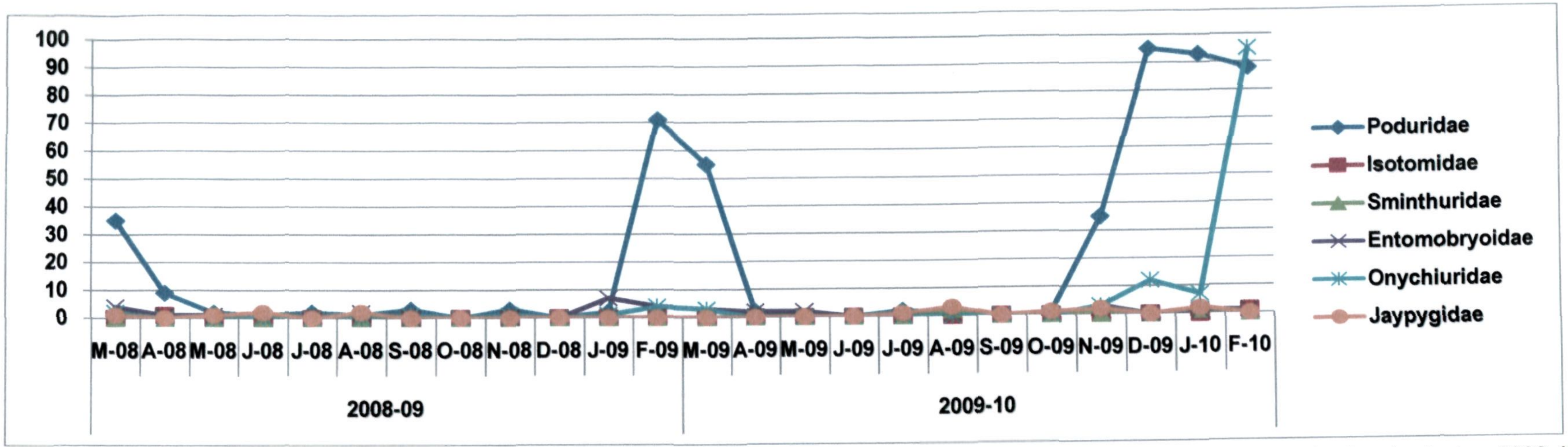


Figure 19e: Comparison of population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Mango Orchards during 2008-10

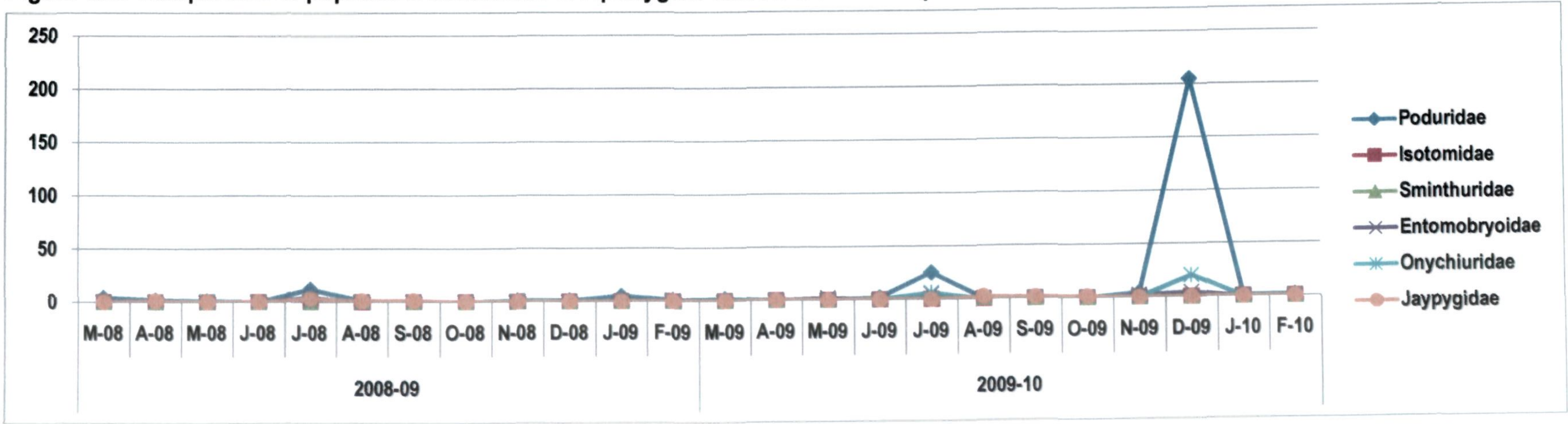


Figure 19f: Comparison of population fluctuation of Apterygote insects from the Litter at the site of Mango Orchards during 2008-10

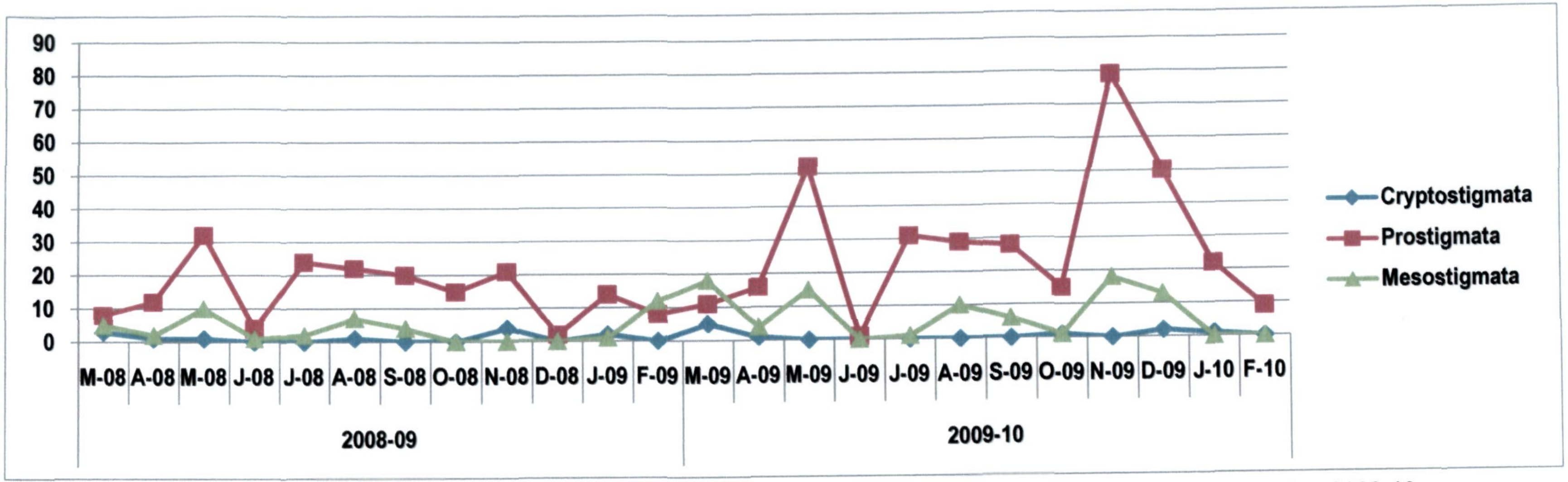


Figure 19g: Comparison of population fluctuation of Mites from the depth of 0-5cm at the site of Mango Orchards during 2008-10

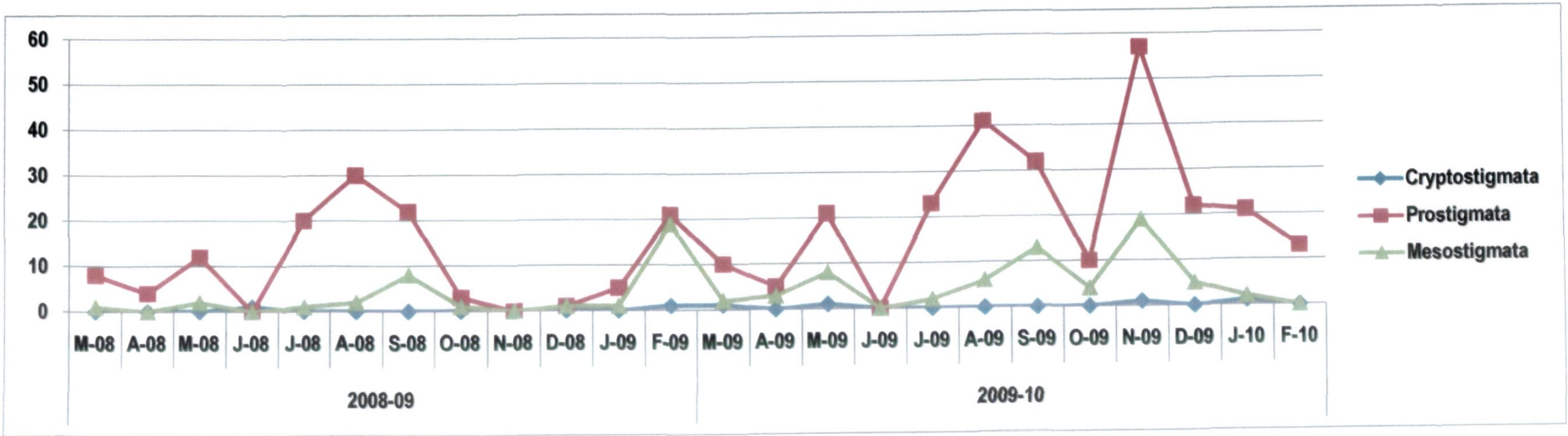


Figure 19h: Comparison of population fluctuation of Mites from the depth of 5-10cm at the site of Mango Orchards during 2008-10

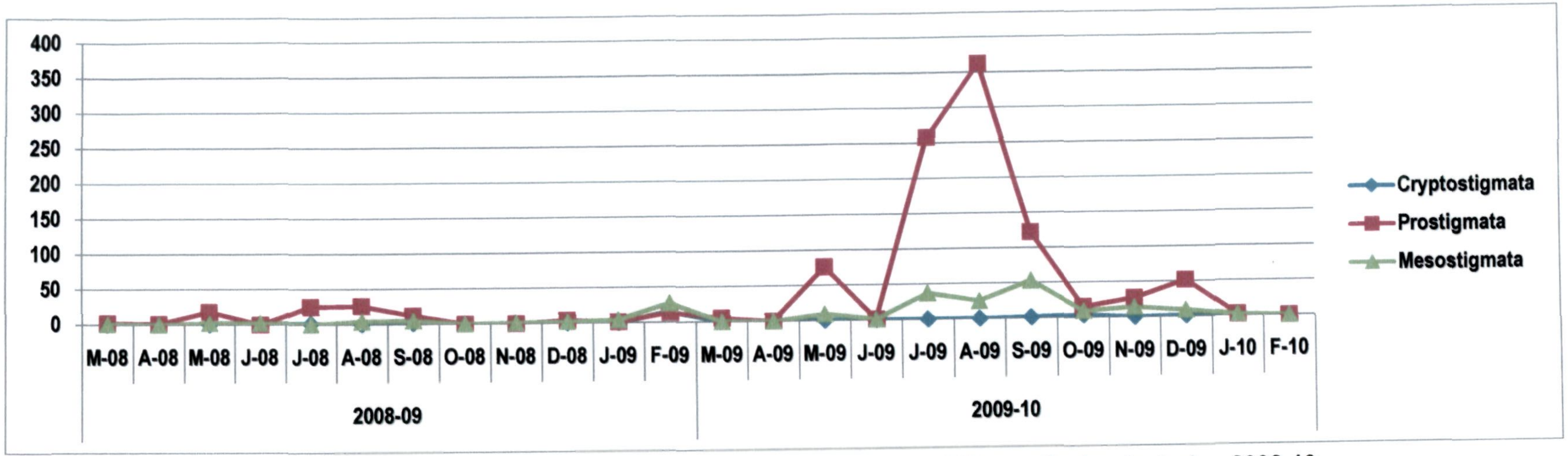


Figure 19i: Comparison of population fluctuation of Mites from the Litter at the site of Mango Orchards during 2008-10

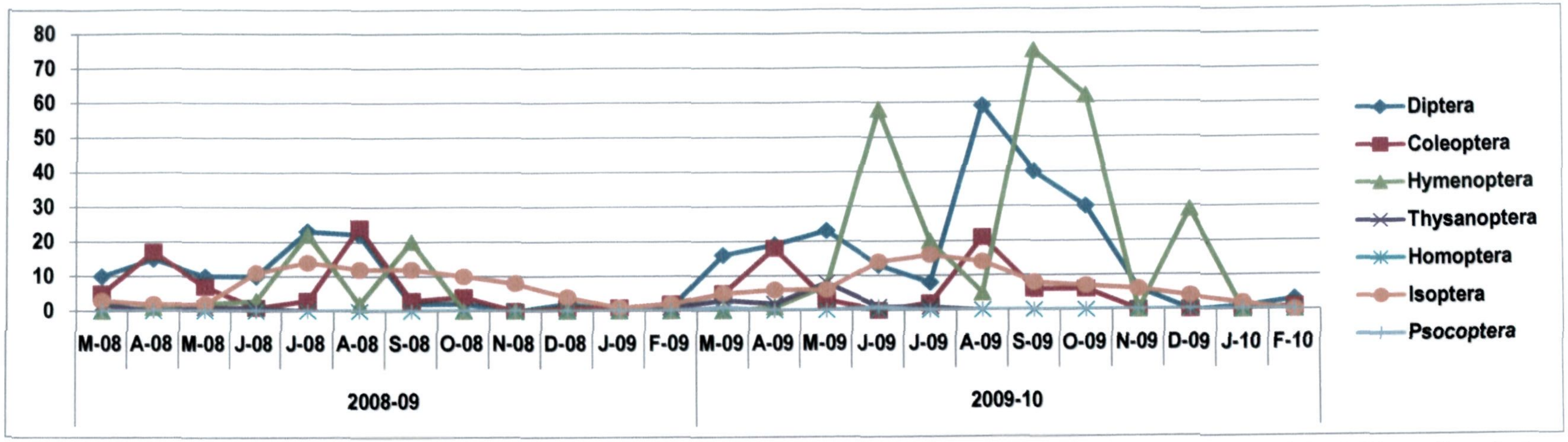


Figure 20a: Comparison of population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2008-10

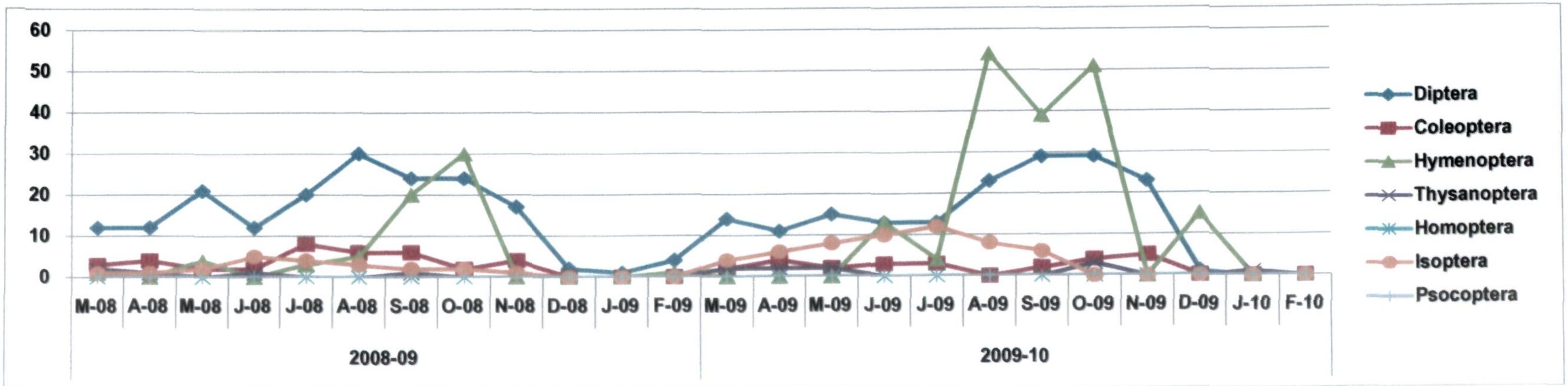


Figure 20b: Comparison of population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2008-10

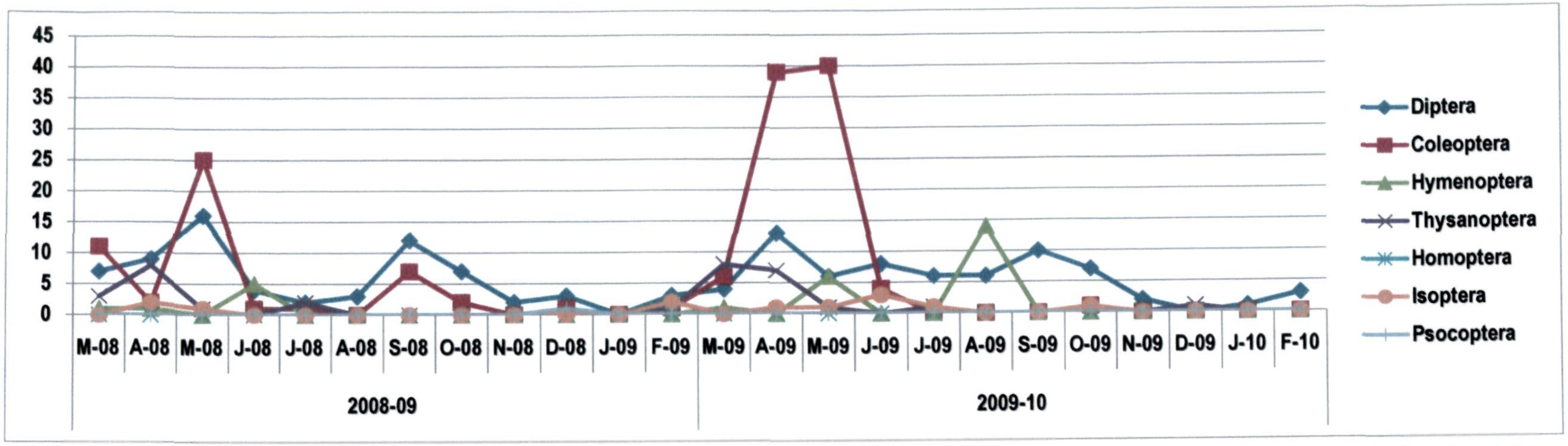


Figure 20c: Comparison of population fluctuation of Pterygote insects from the Litter at the site of Teak Plantation during 2008-10

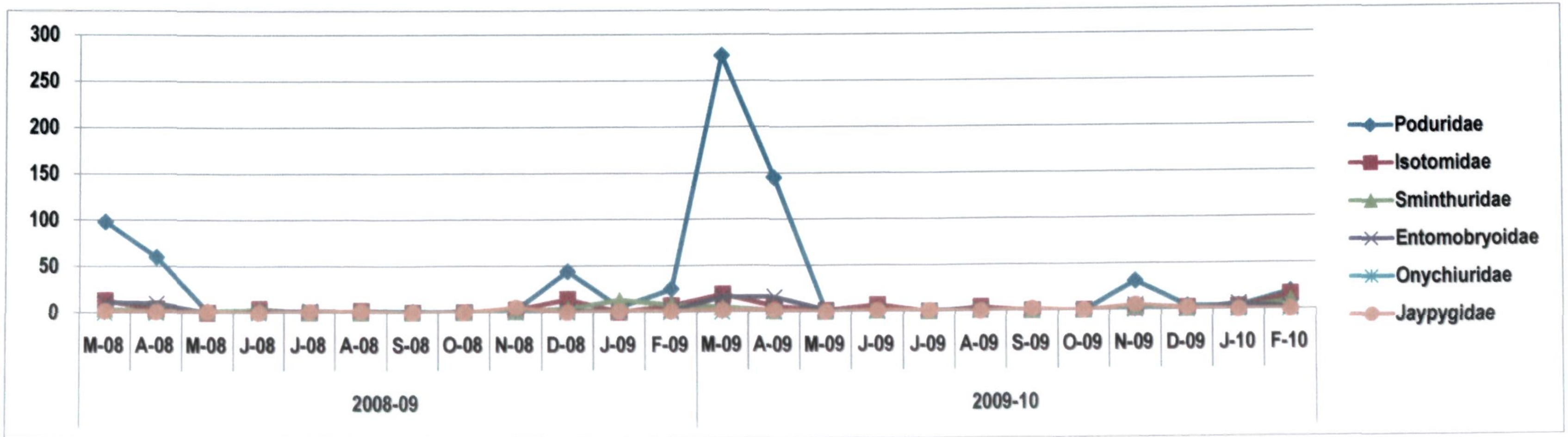


Figure 20d: Comparison of population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Teak Plantation during 2008-10

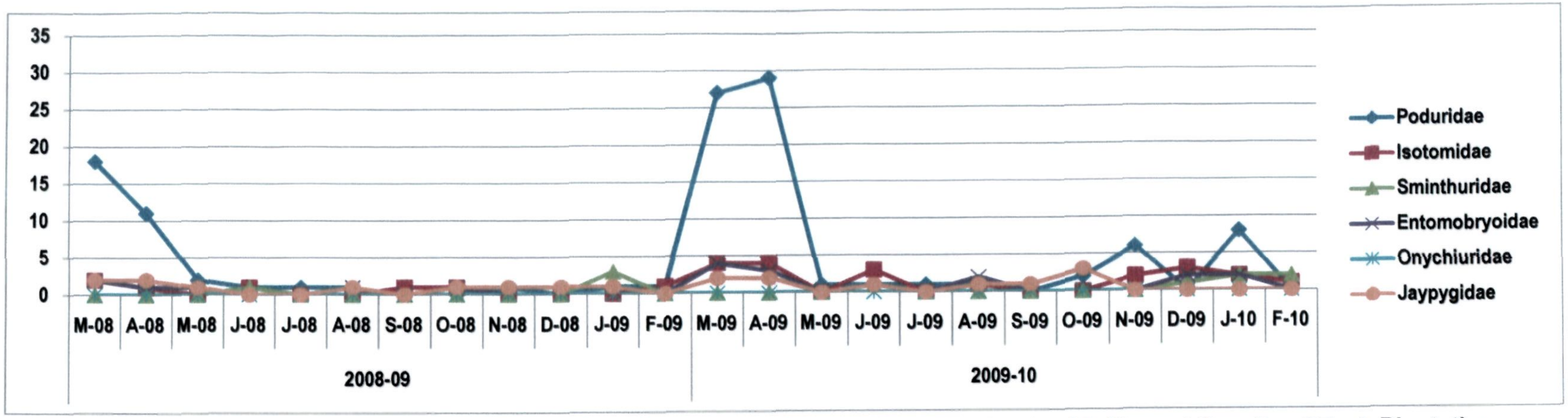


Figure 20e: Comparison of population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Teak Plantation during 2008-10

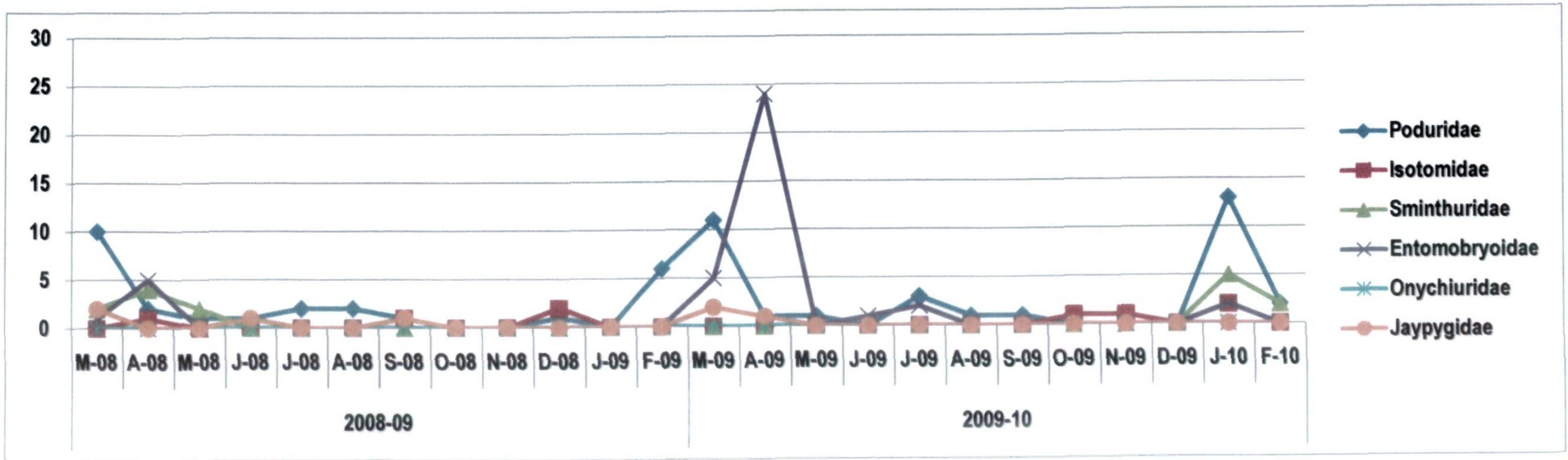


Figure 20f: Comparison of population fluctuation of Apterygote insects from the Litter at the site of Teak Plantation during 2008-10

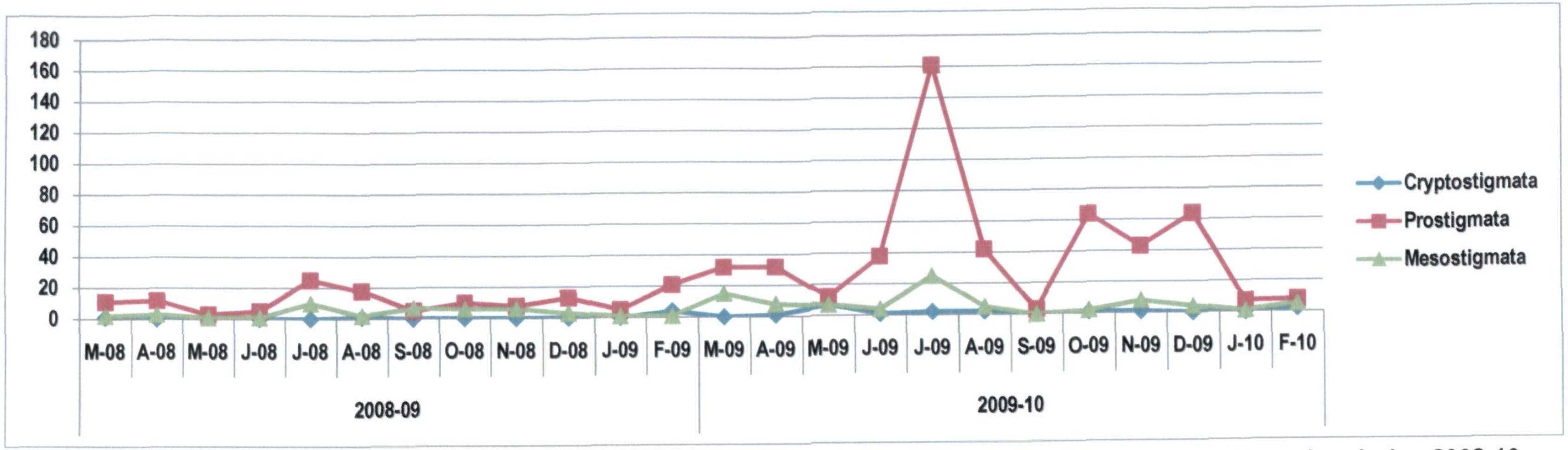


Figure 20g: Comparison of population fluctuation of Mites from the depth of 0-5cm at the site of Teak Plantation during 2008-10

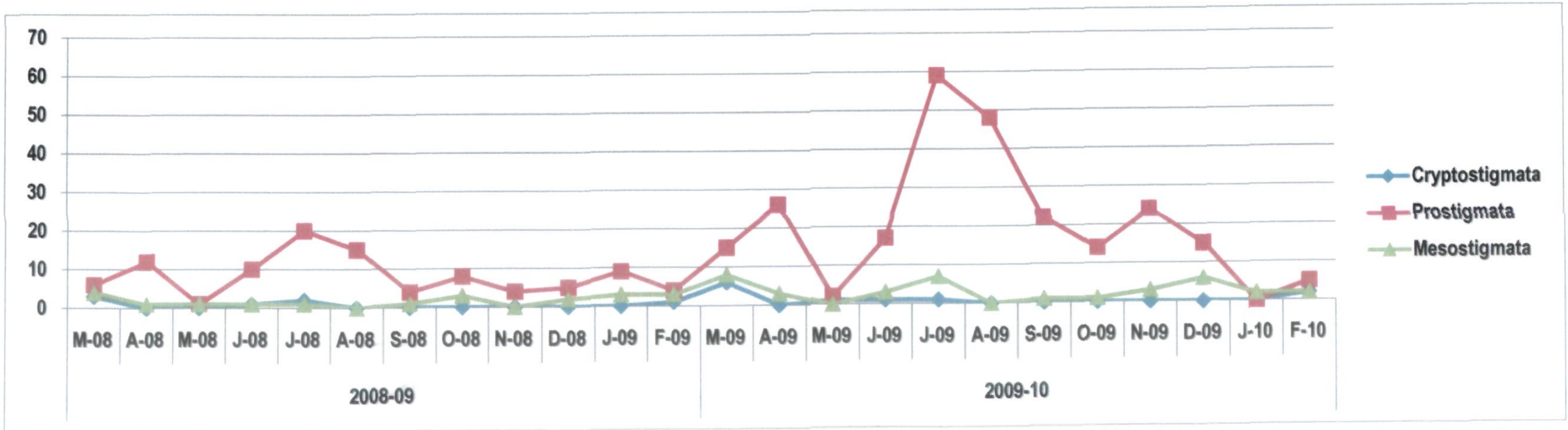


Figure 20h: Comparison of population fluctuation of Mites from the depth of 5-10cm at the site of Teak Plantation during 2008-10

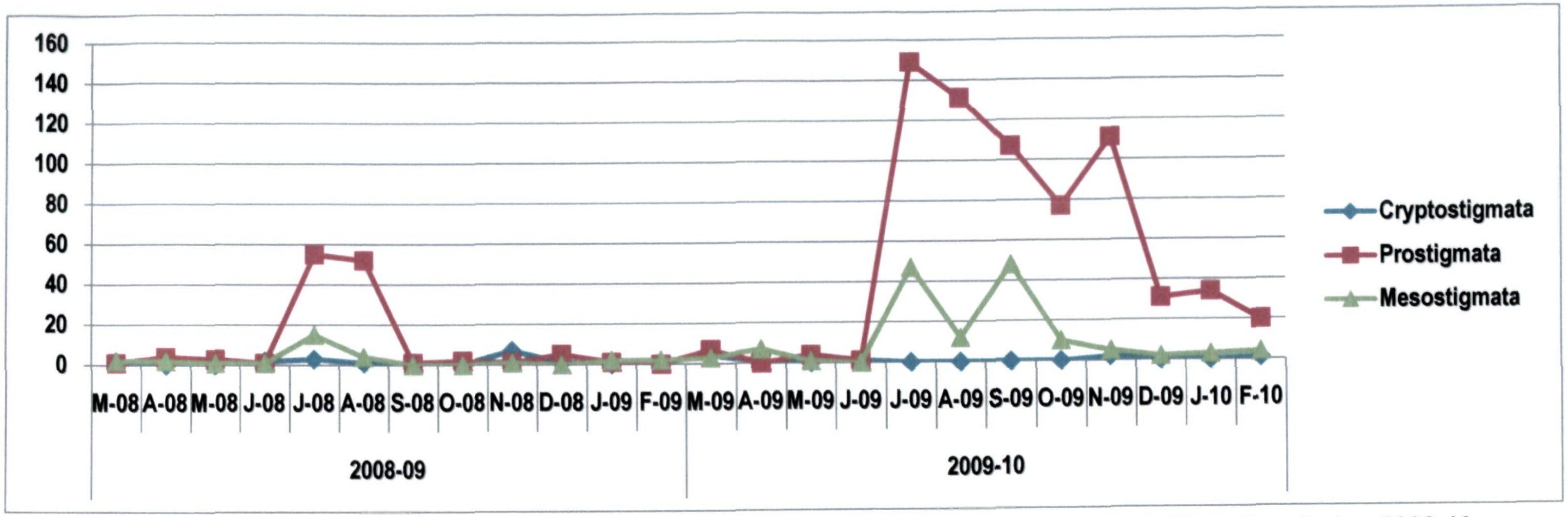


Figure 20i: Comparison of population fluctuation of Mites from the Litter at the site of Teak Plantation during 2008-10

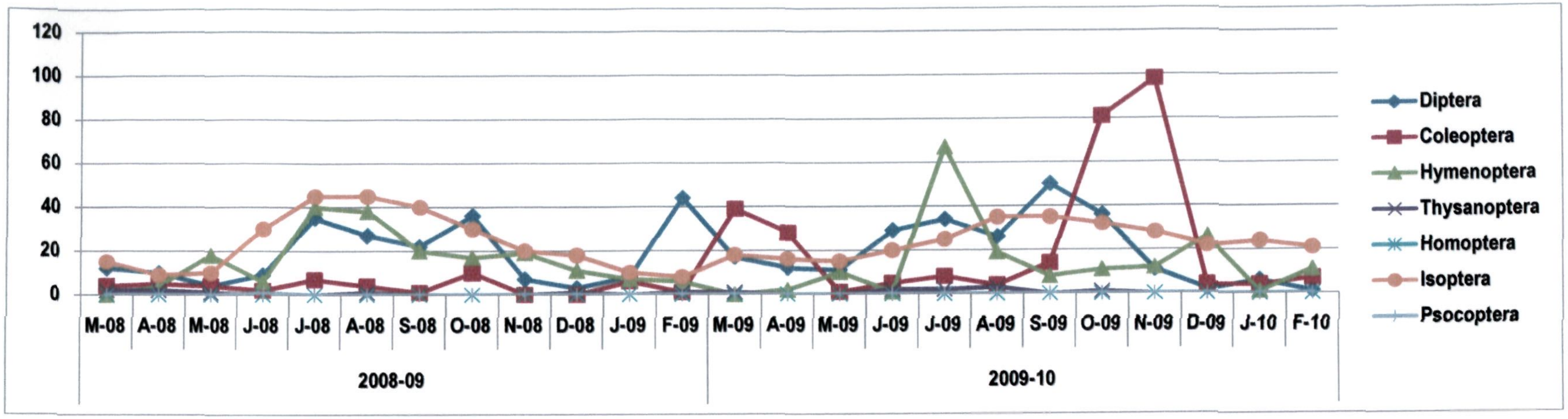


Figure 21a: Comparison of population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Unarable Land during 2008-10

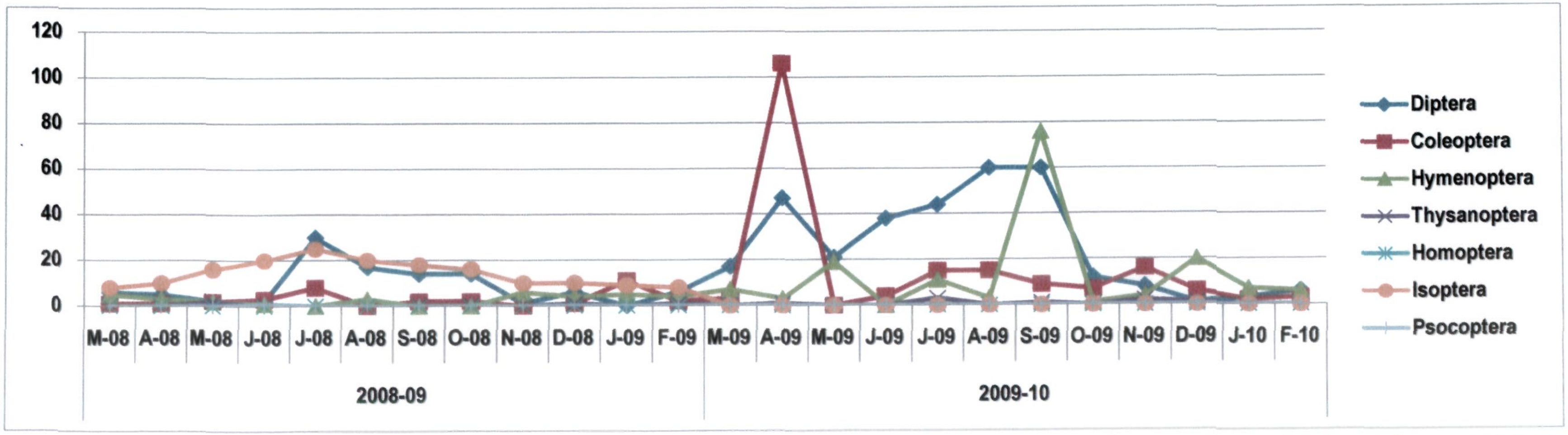


Figure 21b: Comparison of population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Unarable Land during 2008-10

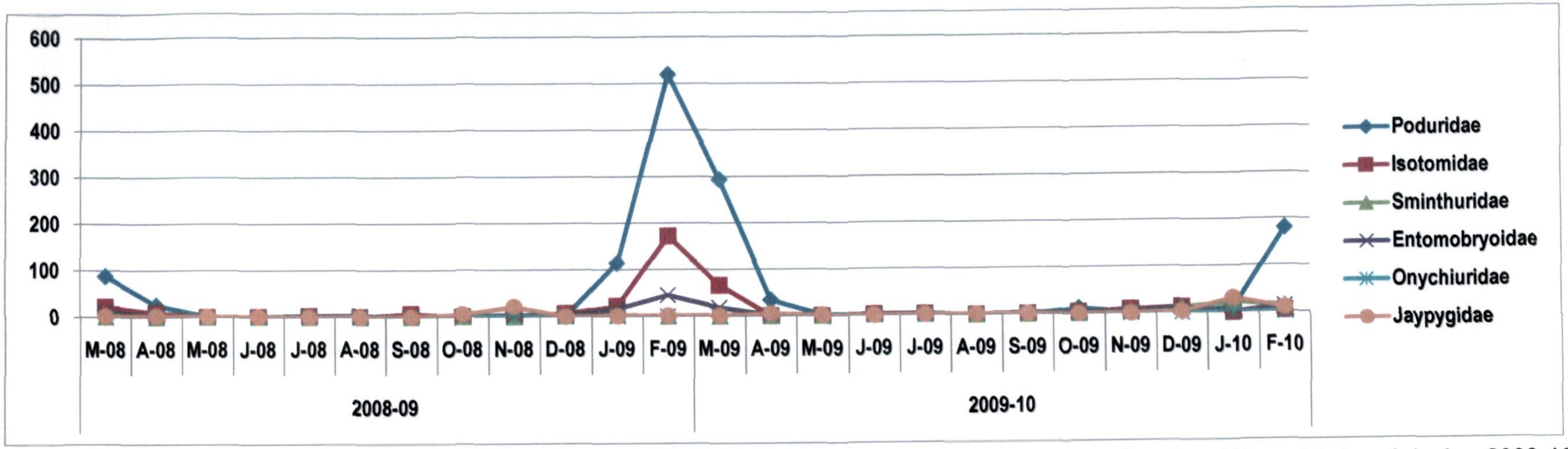


Figure 21c:Comparison of population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Unarable Land during 2008-10

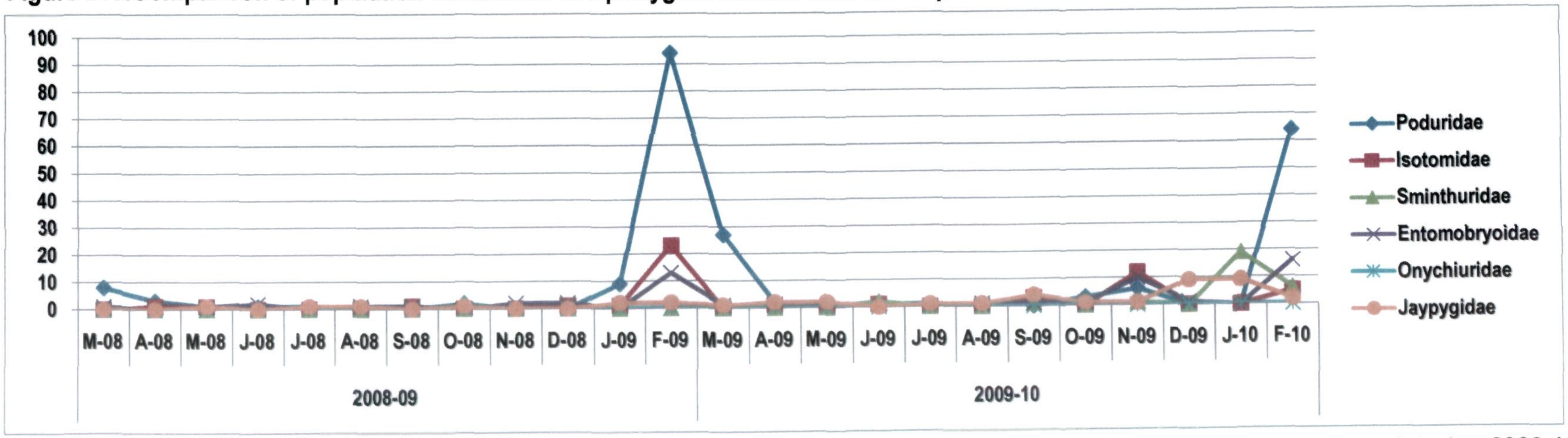


Figure 21d:Comparison of population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Unarable Land during 2008-10

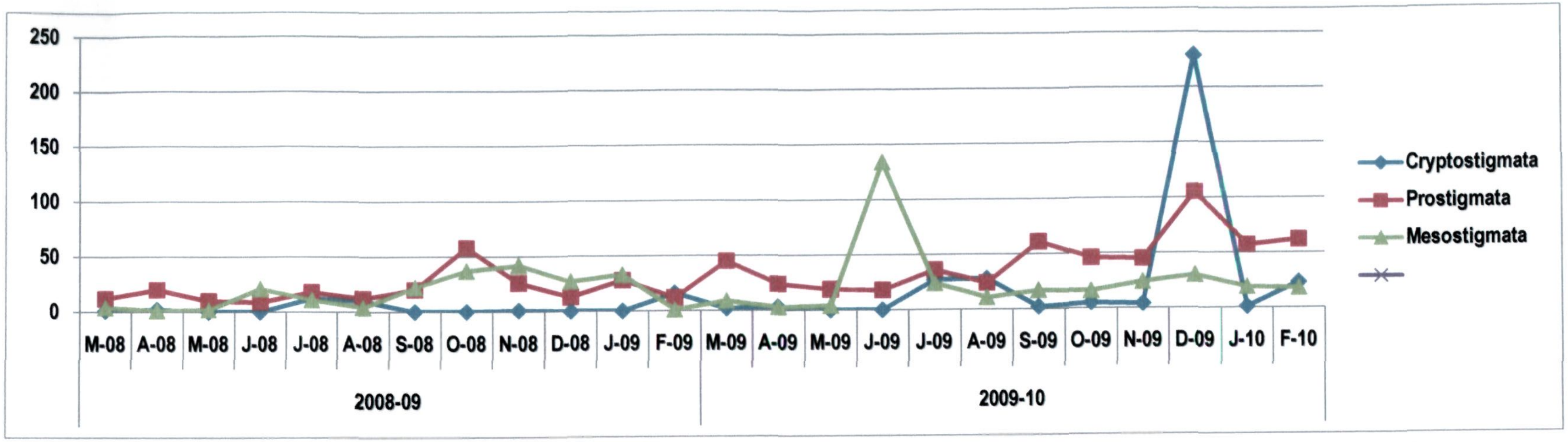


Figure 21e: Comparison of population fluctuation of Mites from the depth of 0-5cm at the site of Unarable Land during 2008-10

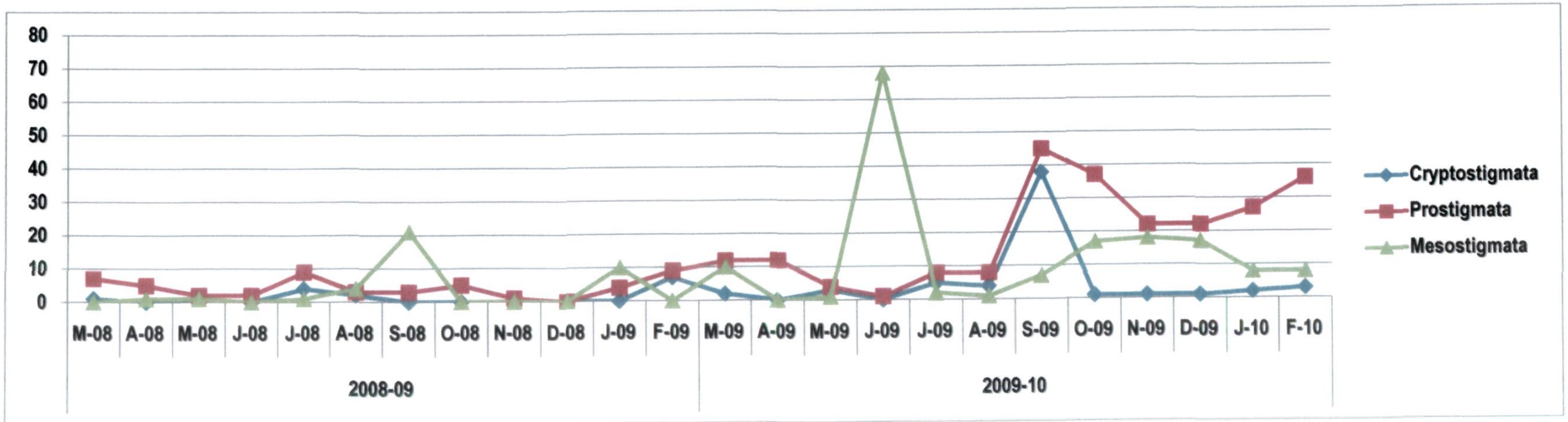


Figure 21f: Comparison of population fluctuation of Mites from the depth of 5-10cm at the site of Unarable Land during 2008-10

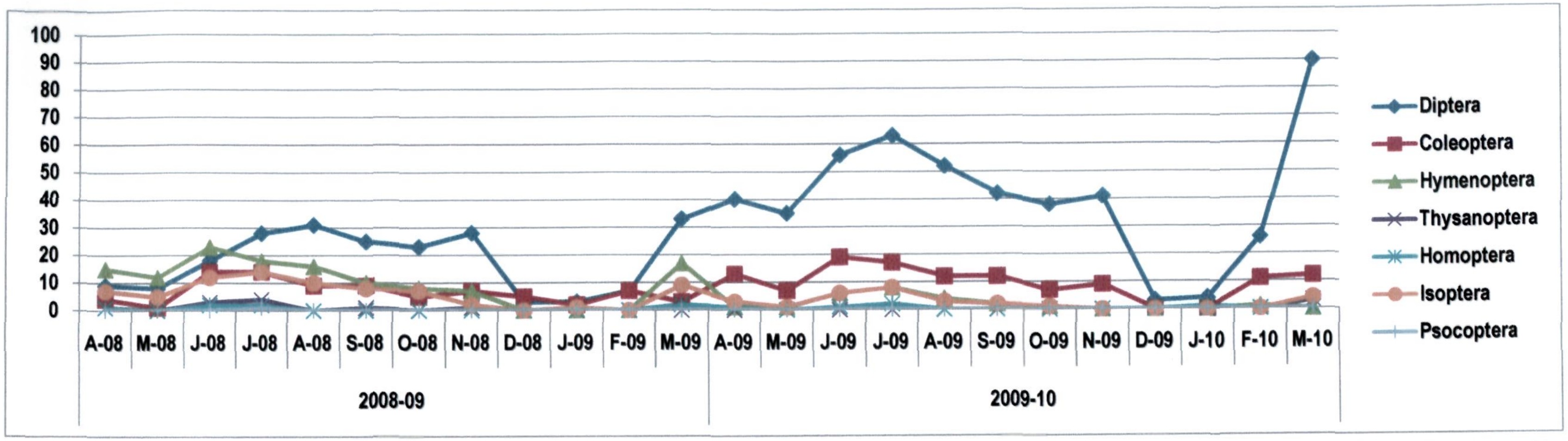


Figure 22a: Comparison of population fluctuation of Pterygote insects from the depth of 0-5cm at the site of Wheat Field during 2008-10

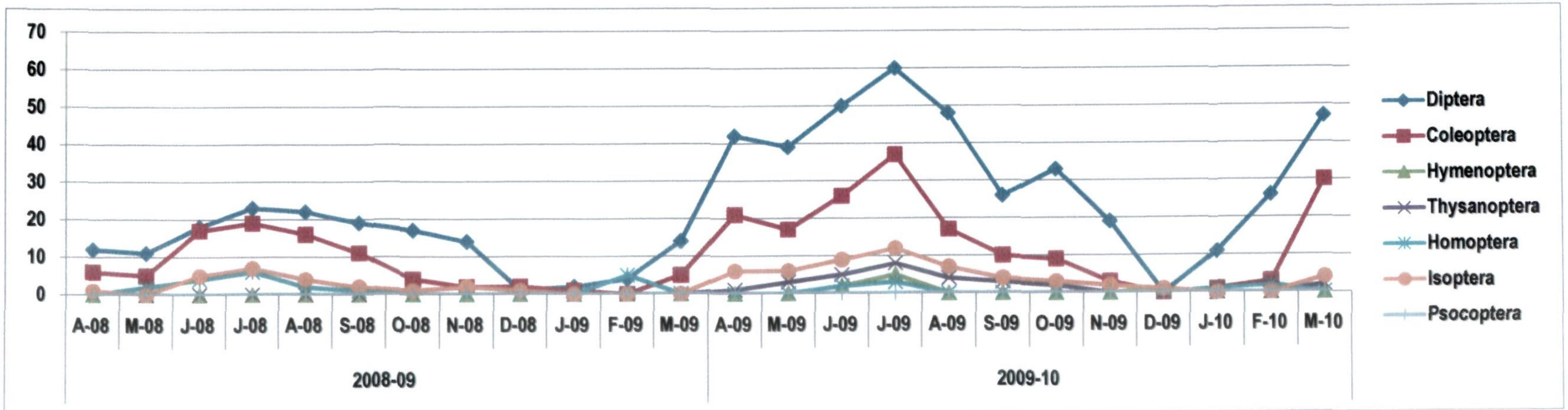


Figure 22b: Comparison of population fluctuation of Pterygote insects from the depth of 5-10cm at the site of Wheat Field during 2008-10

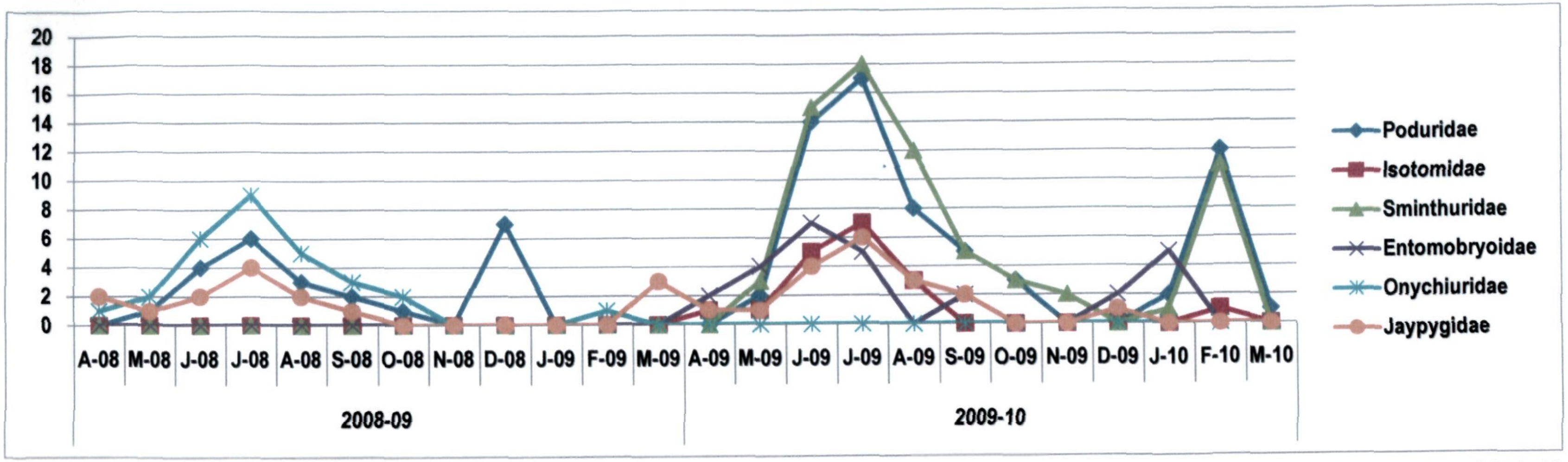


Figure 22c: Comparison of population fluctuation of Apterygote insects from the depth of 0-5cm at the site of Wheat Field during 2008-10

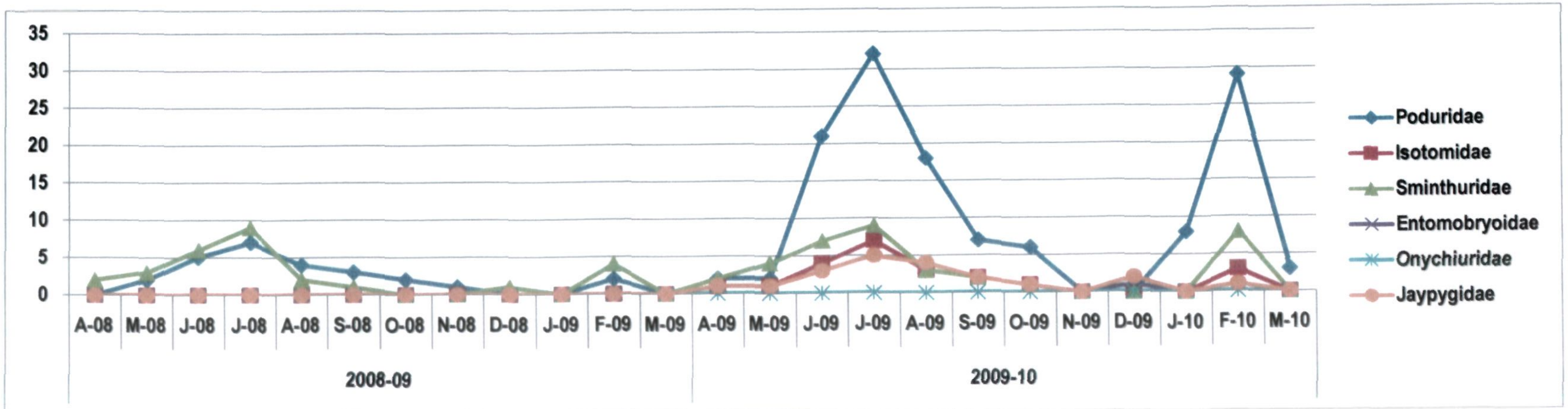


Figure 22d:Comparison of population fluctuation of Apterygote insects from the depth of 5-10cm at the site of Wheat Field during 2008-10

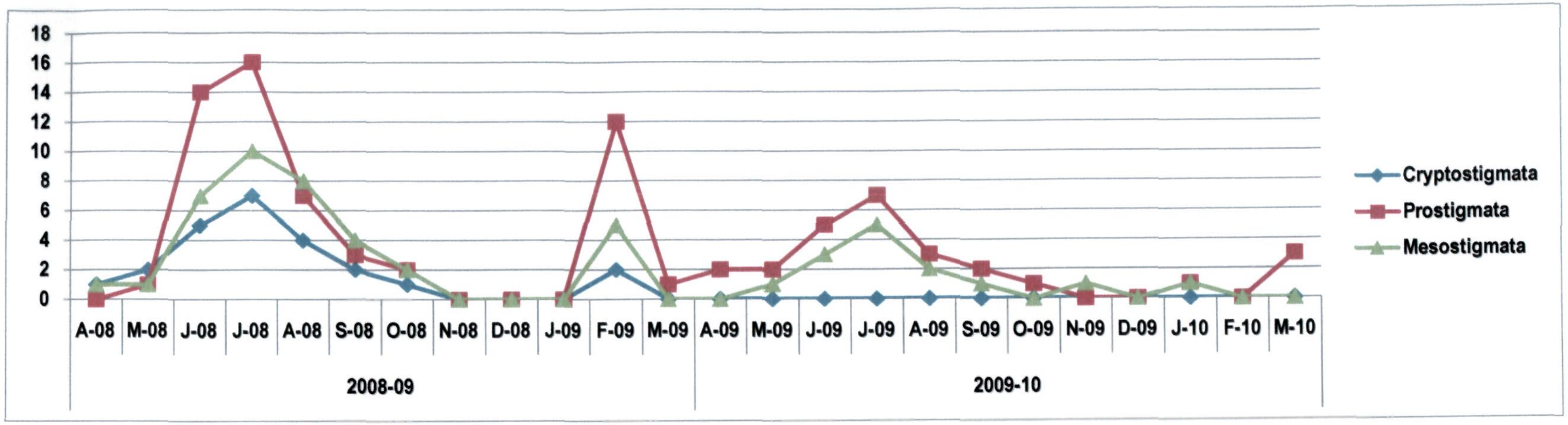


Figure 22e: Comparison of population fluctuation of Mites from the depth of 0-5cm at the site of Wheat Field during 2008-10

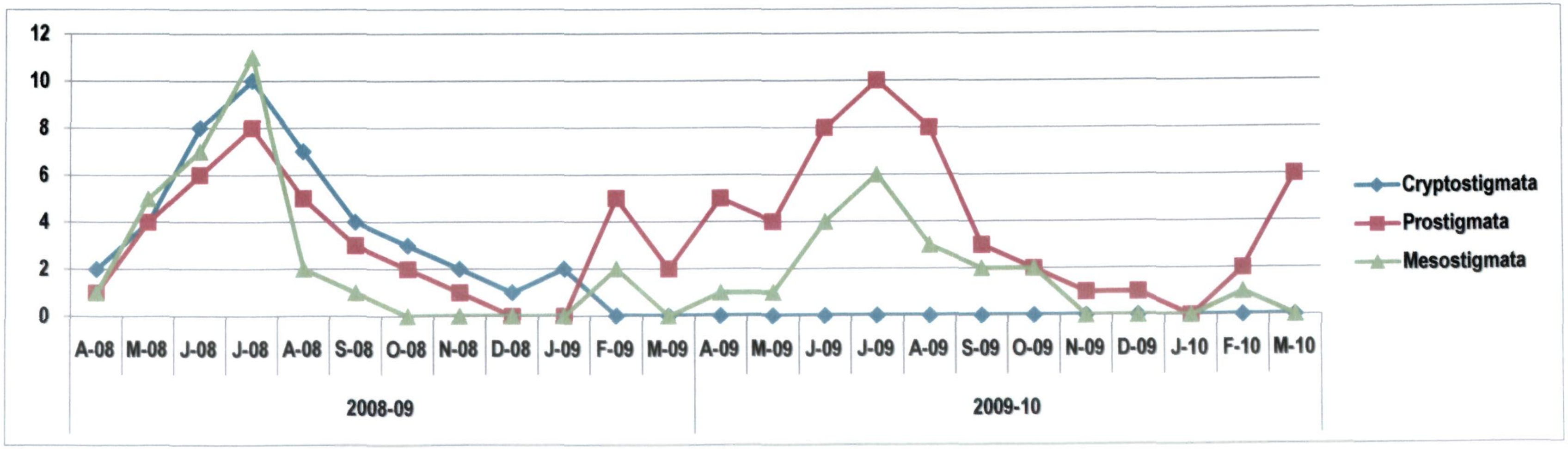


Figure 22f: Comparison of population fluctuation of Mites from the depth of 5-10cm at the site of Wheat Field during 2008-10

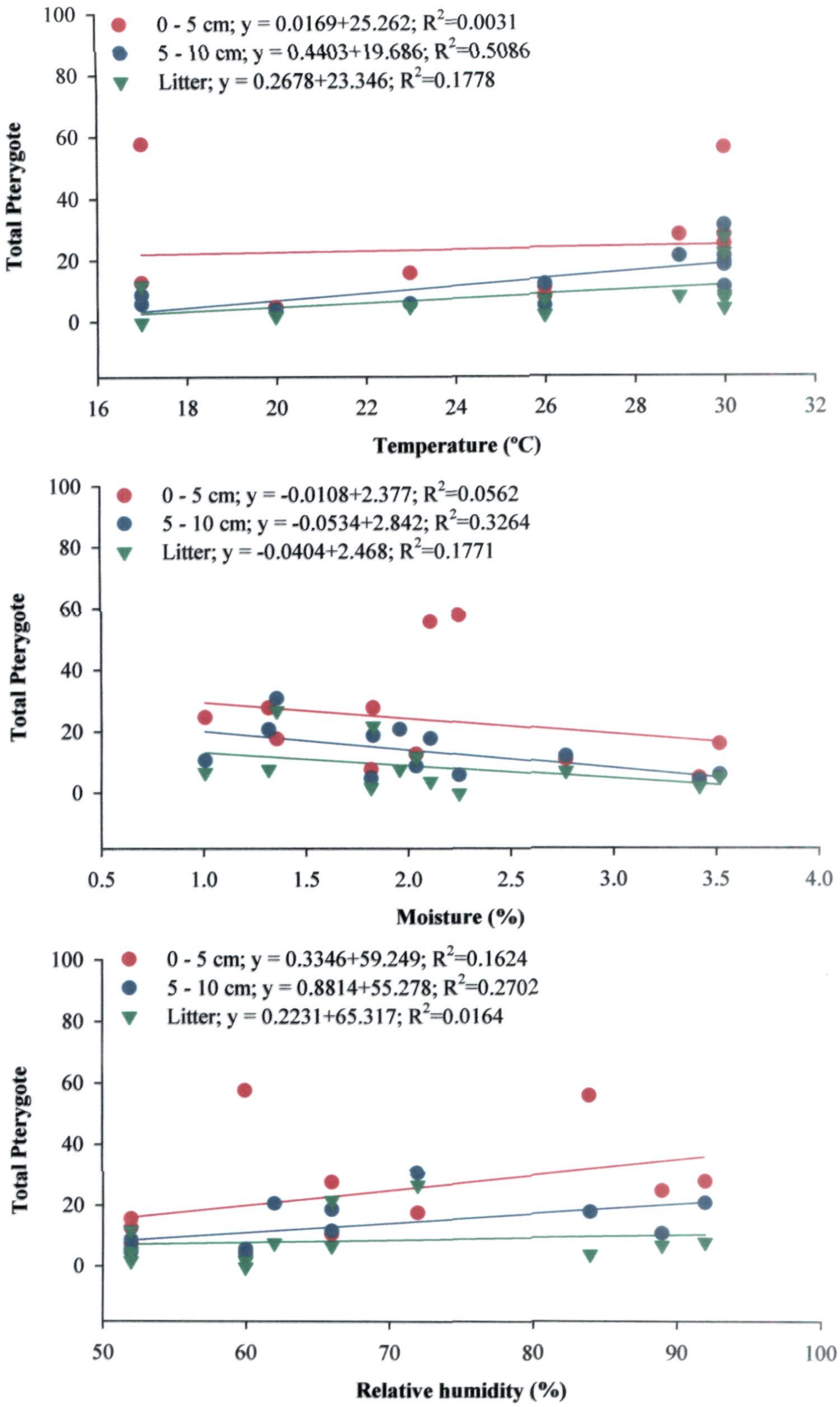


Figure 23a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Mango Orchards during 2008-09

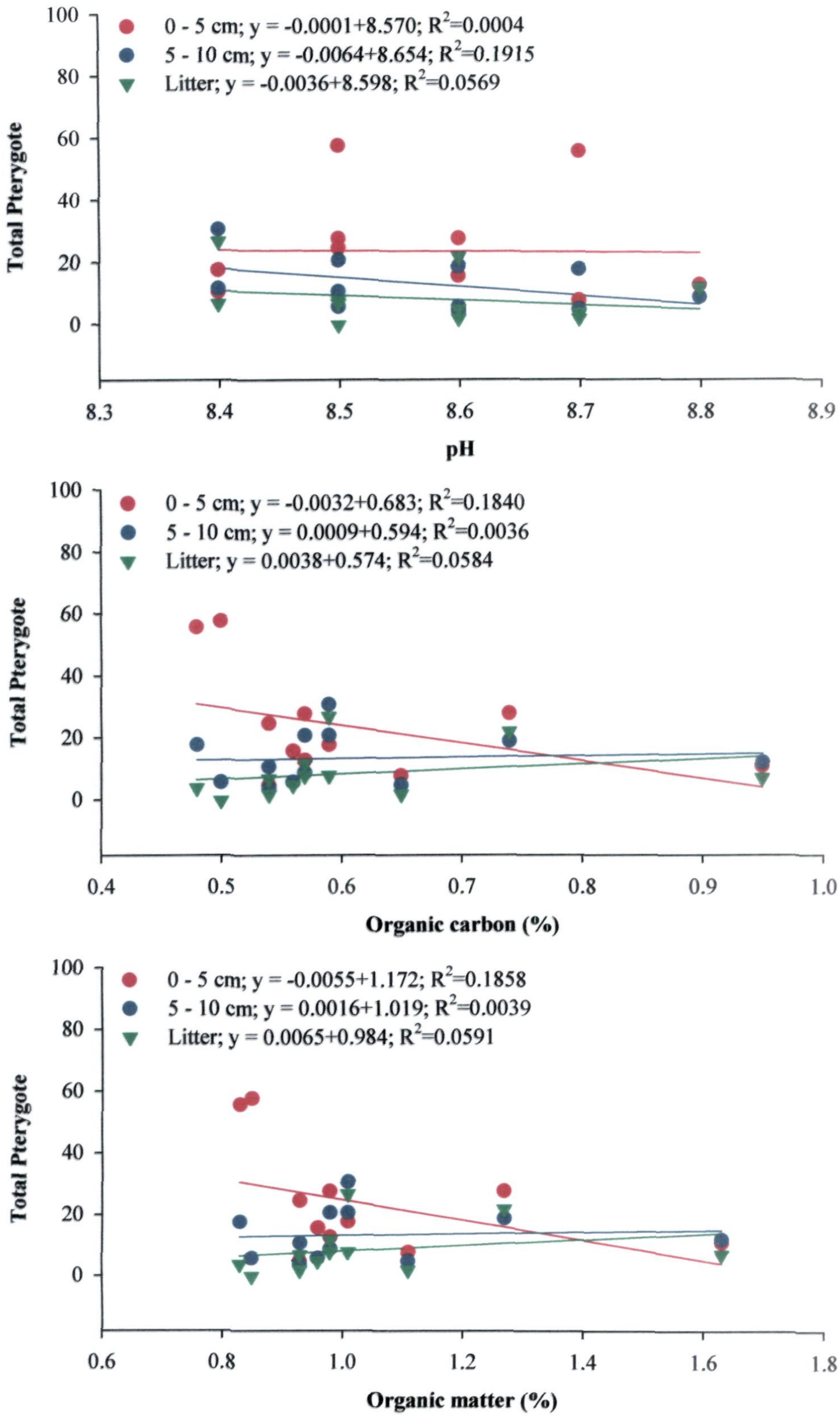


Figure 23b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Mango Orchards during 2008-09

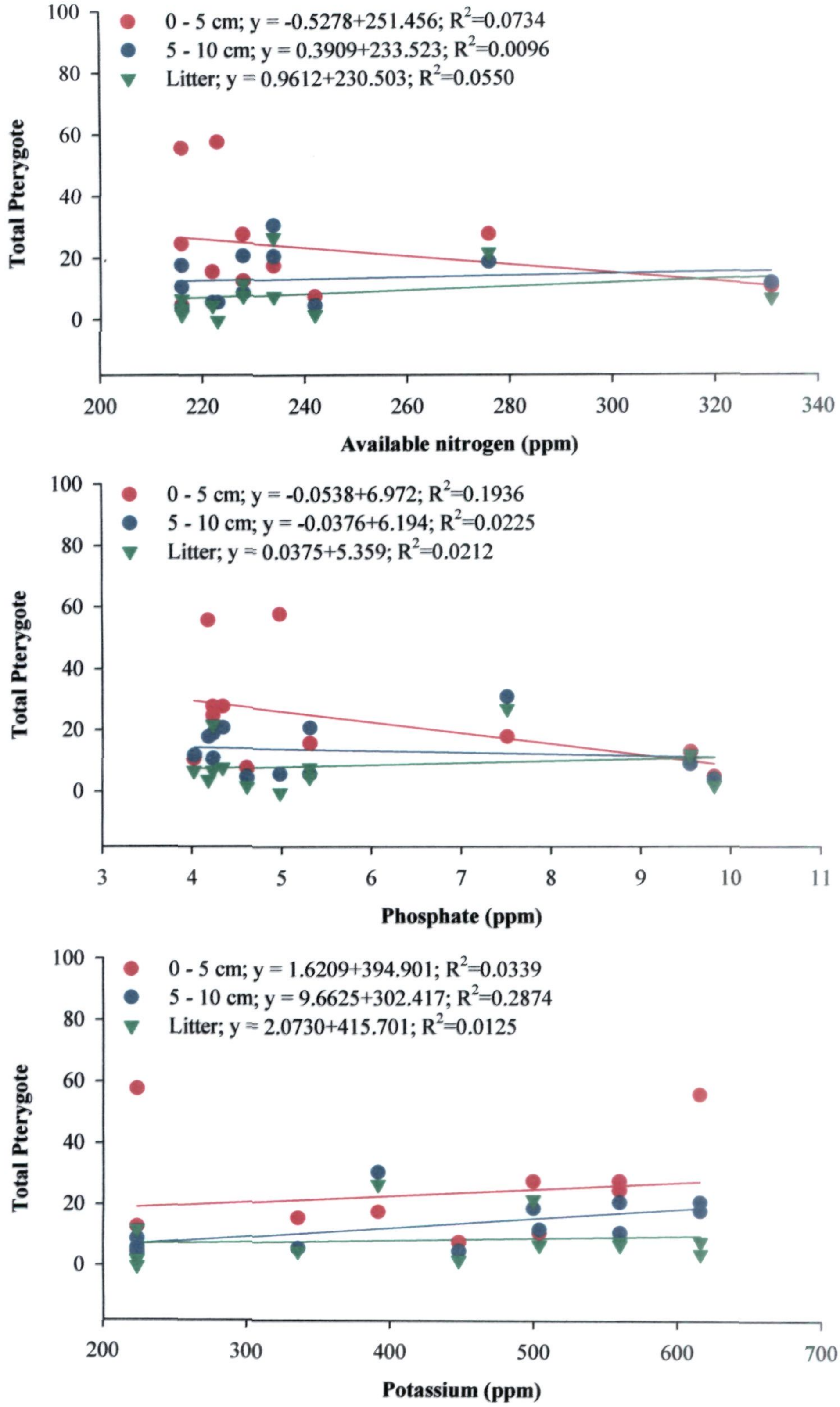


Figure 23c: Regression analysis of total population of pterygote with Available Nitrogen, Phosphate and Potassium Humidity from the site of Mango Orchards during 2008-09

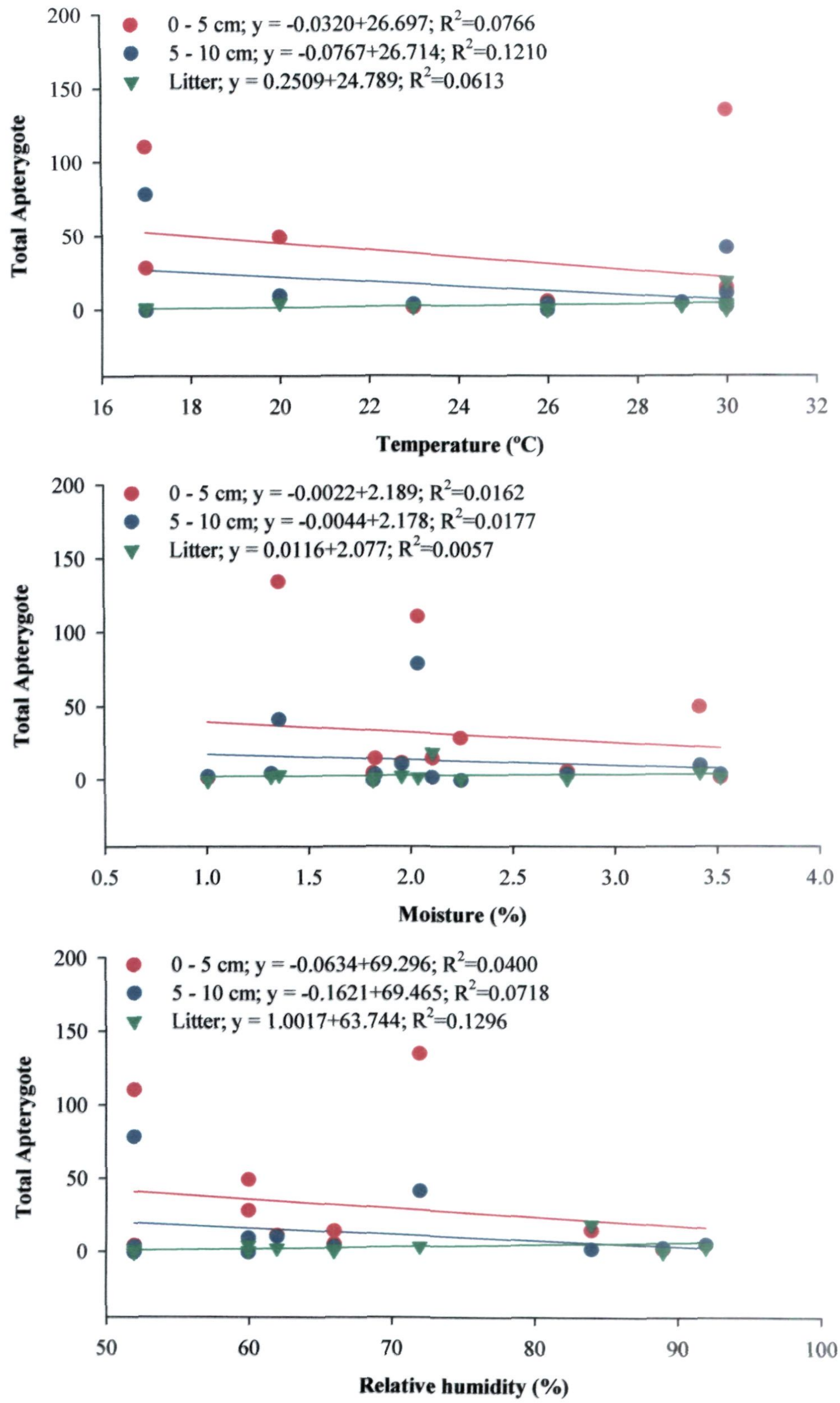


Figure 23d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Mango Orchards during 2008-09

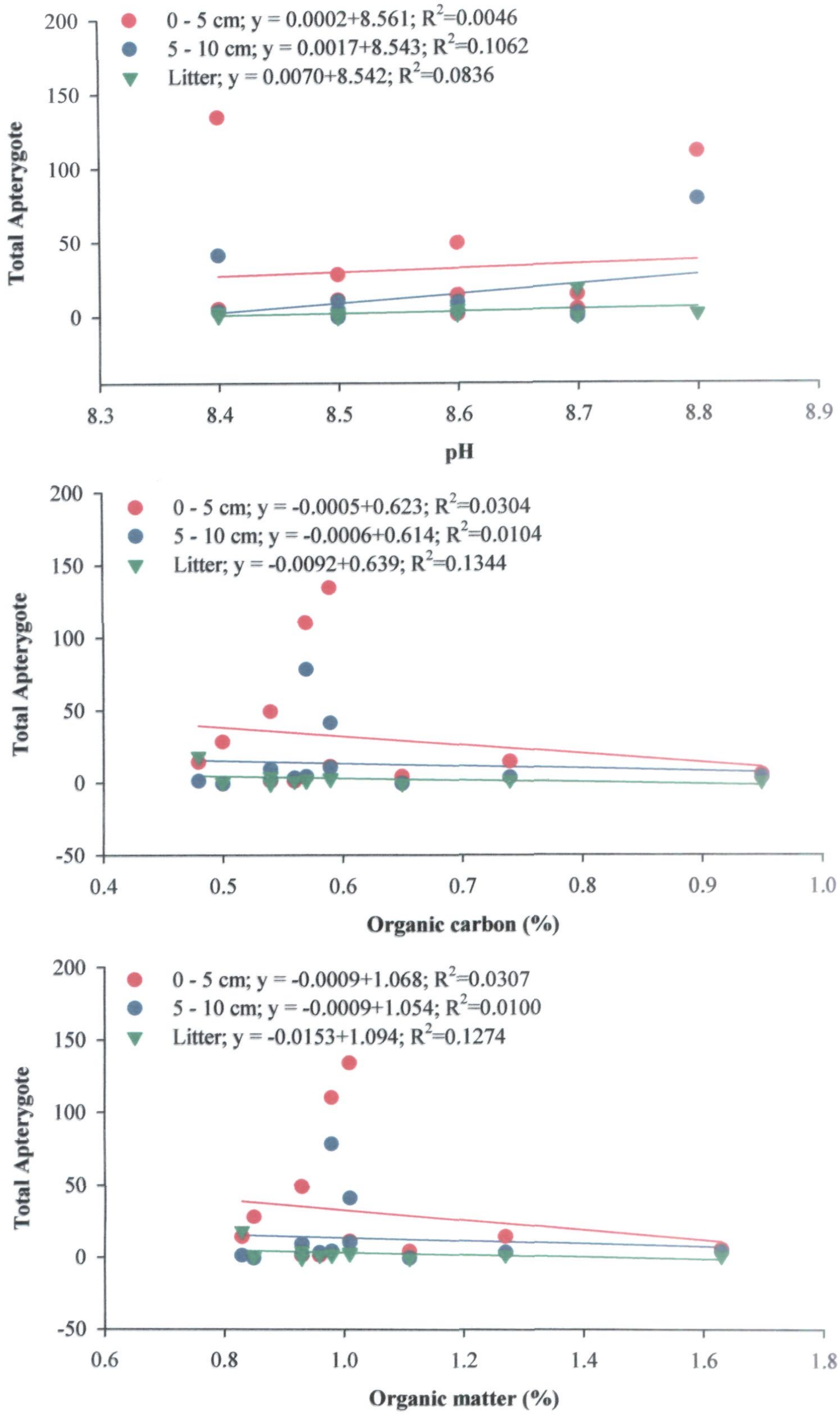


Figure 23e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Mango Orchards during 2008-09

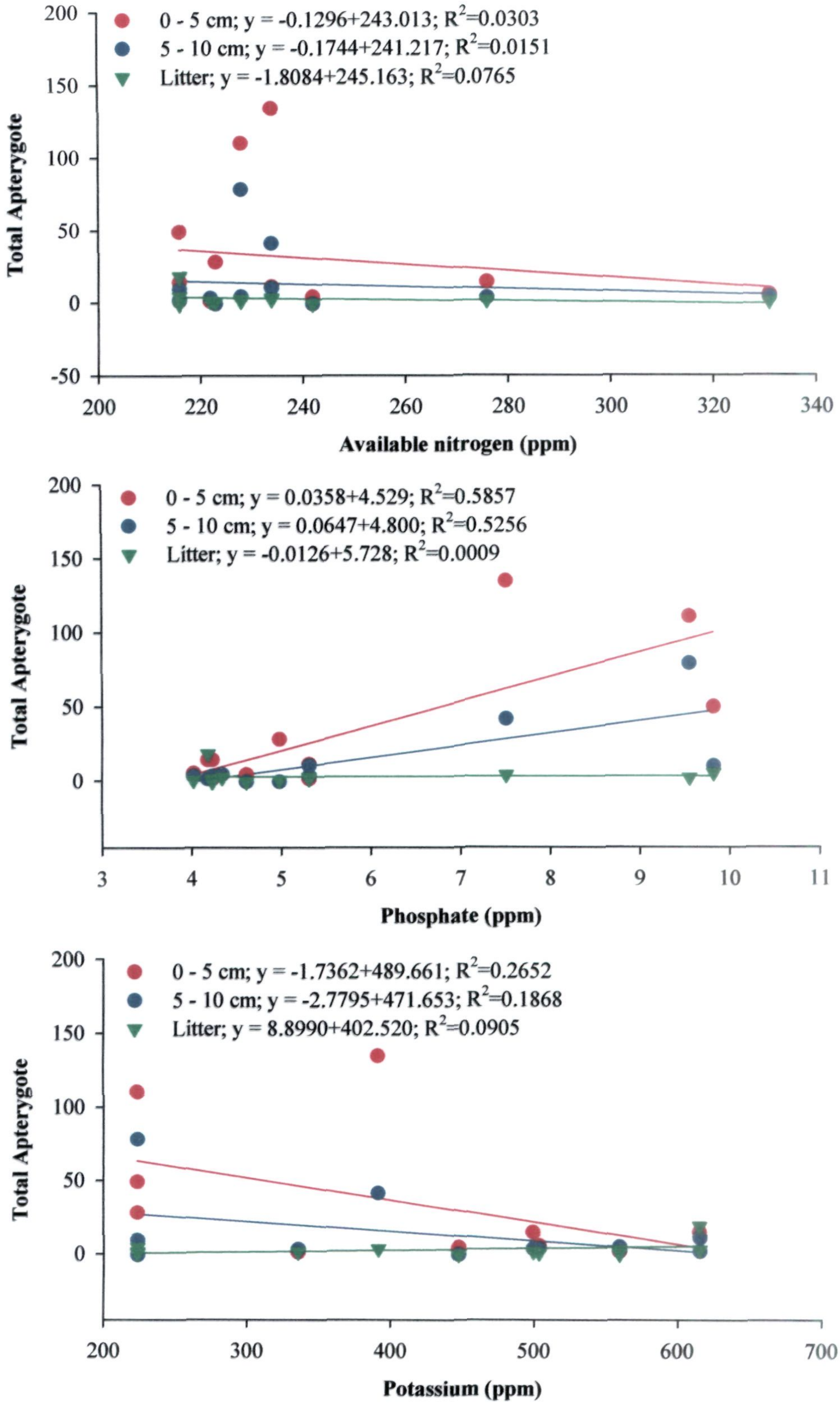


Figure 23f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Mango Orchards during 2008-09

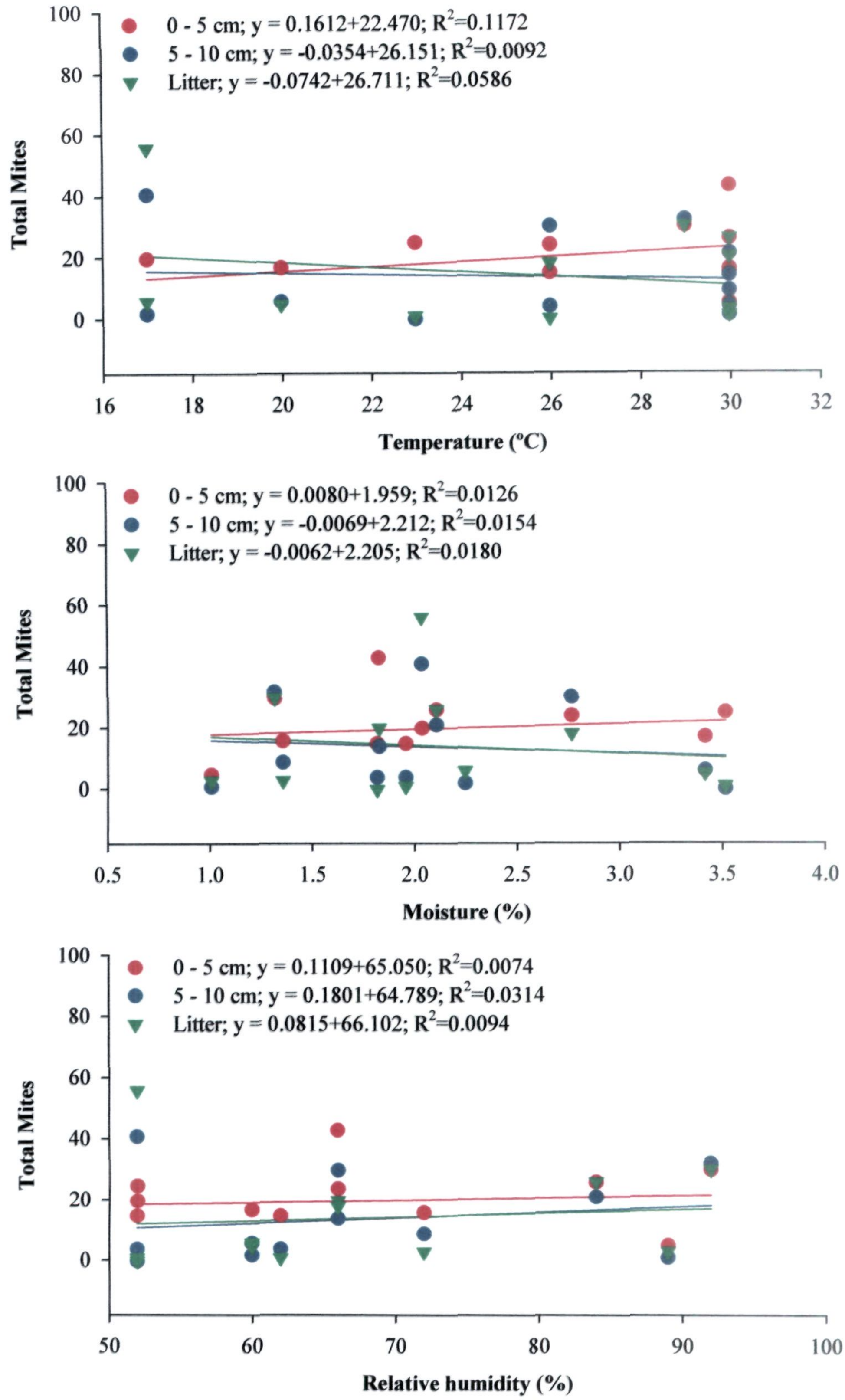


Figure 23g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Mango Orchards during 2008-09

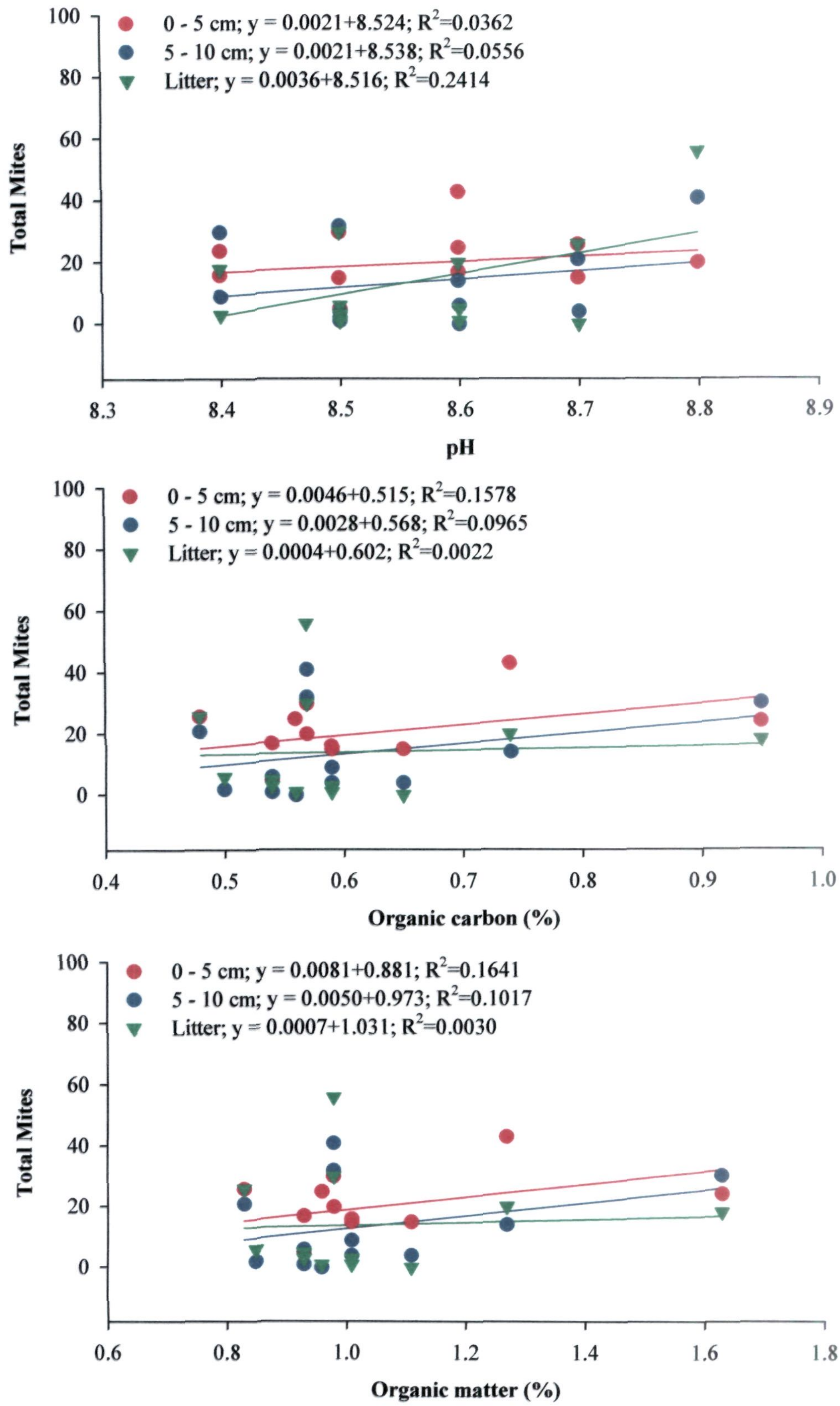


Figure 23h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Mango Orchards during 2008-09

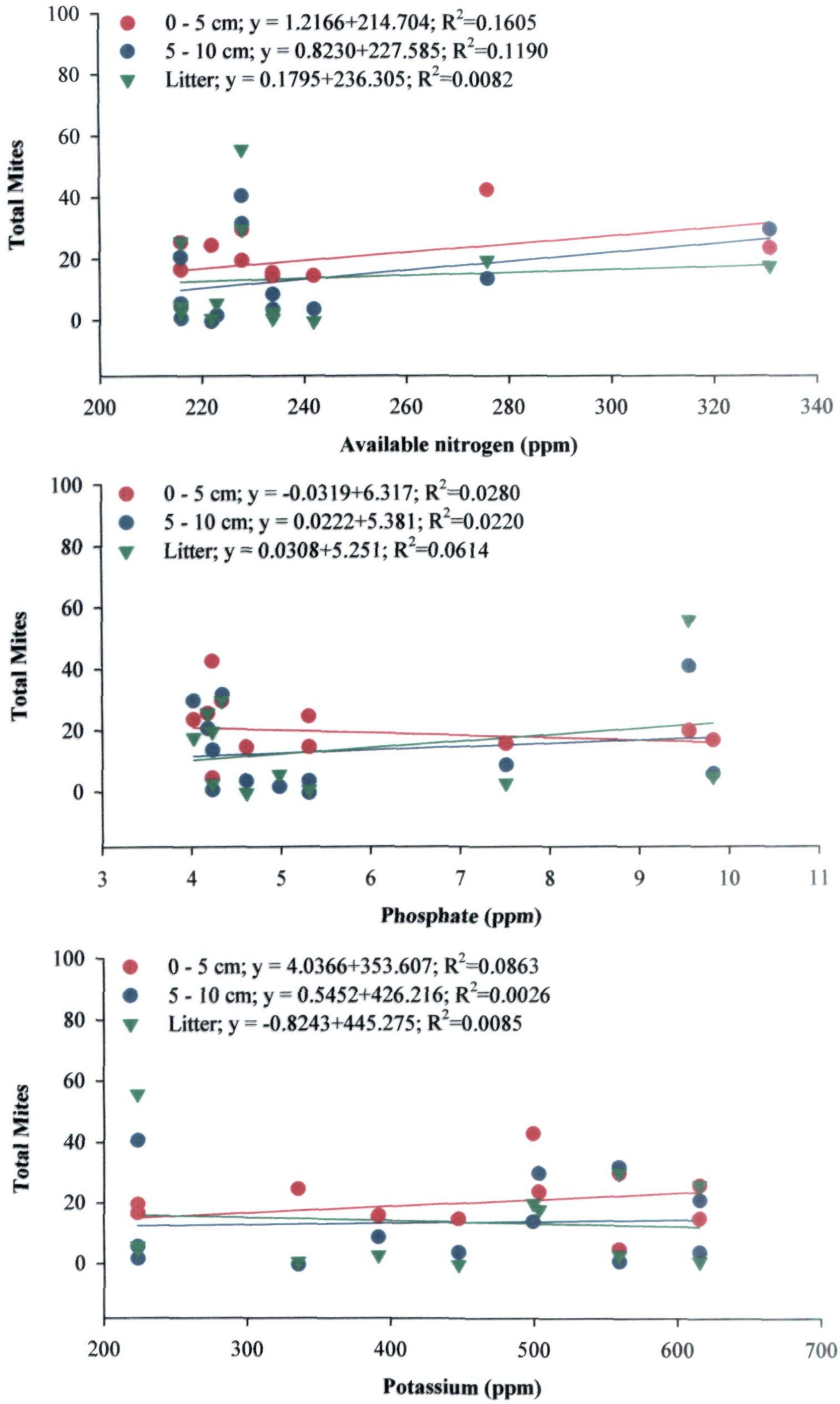


Figure 23i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Mango Orchards during 2008-09

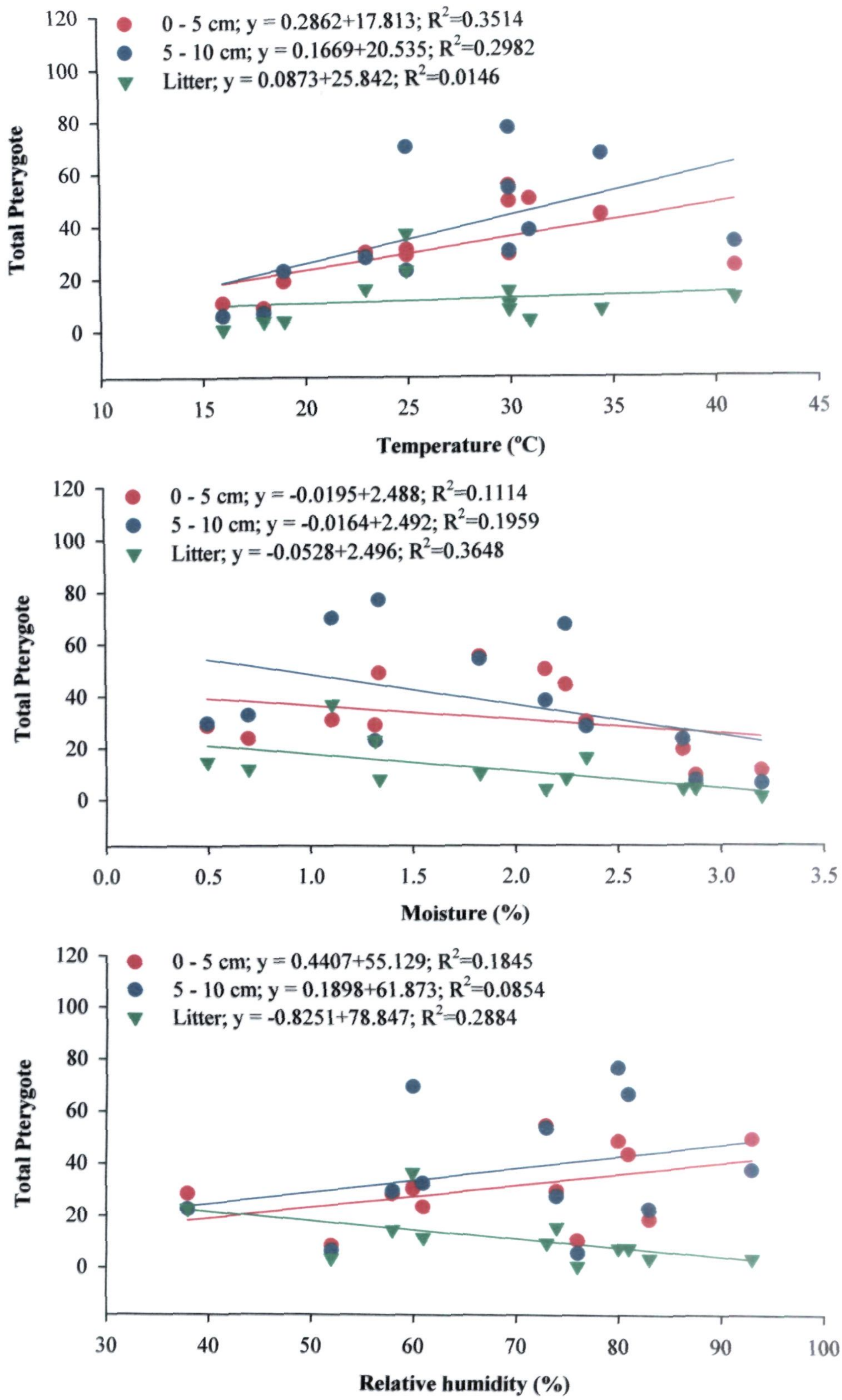


Figure 24a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Mango Orchards during 2009-10

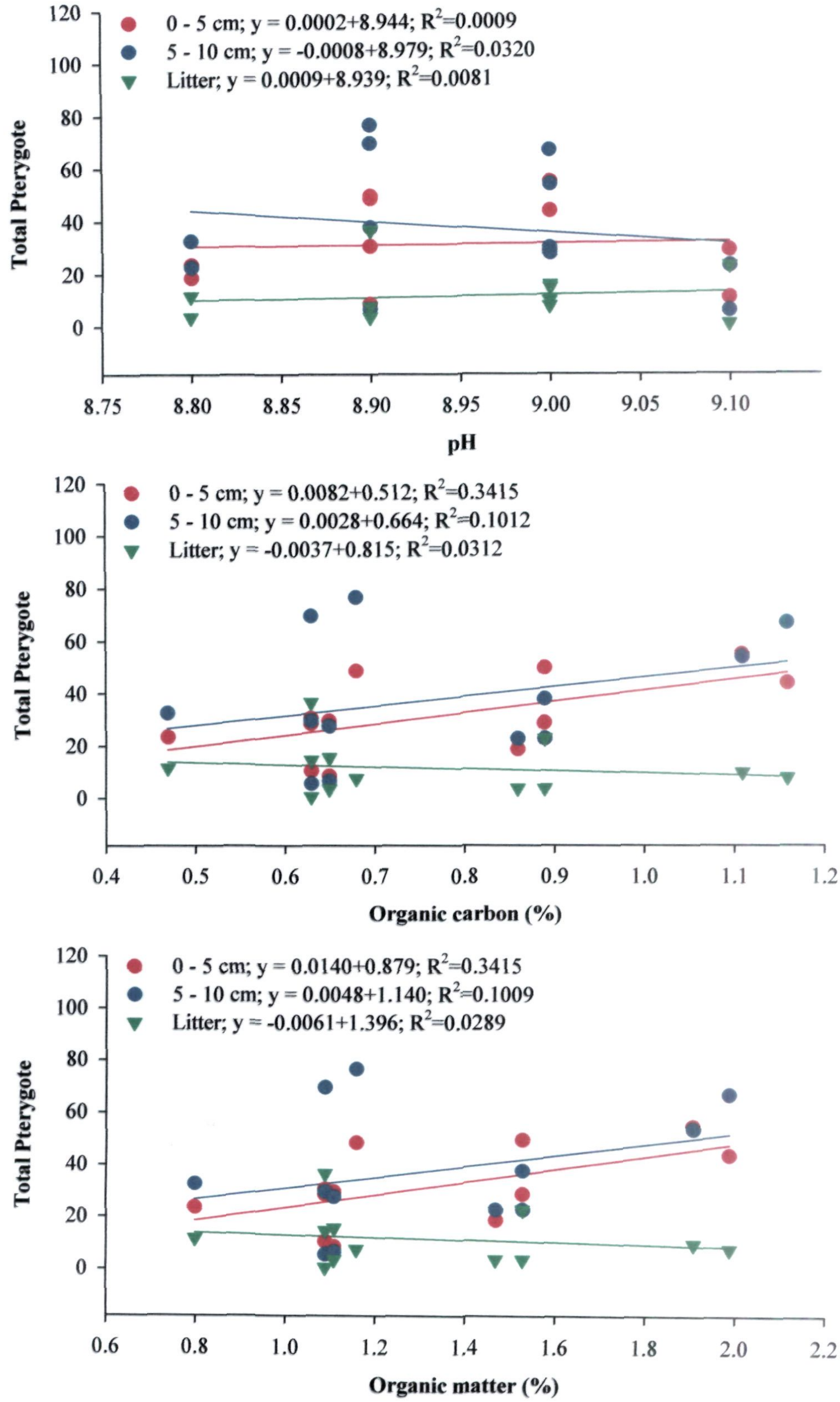


Figure 24b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Mango Orchards during 2009-10

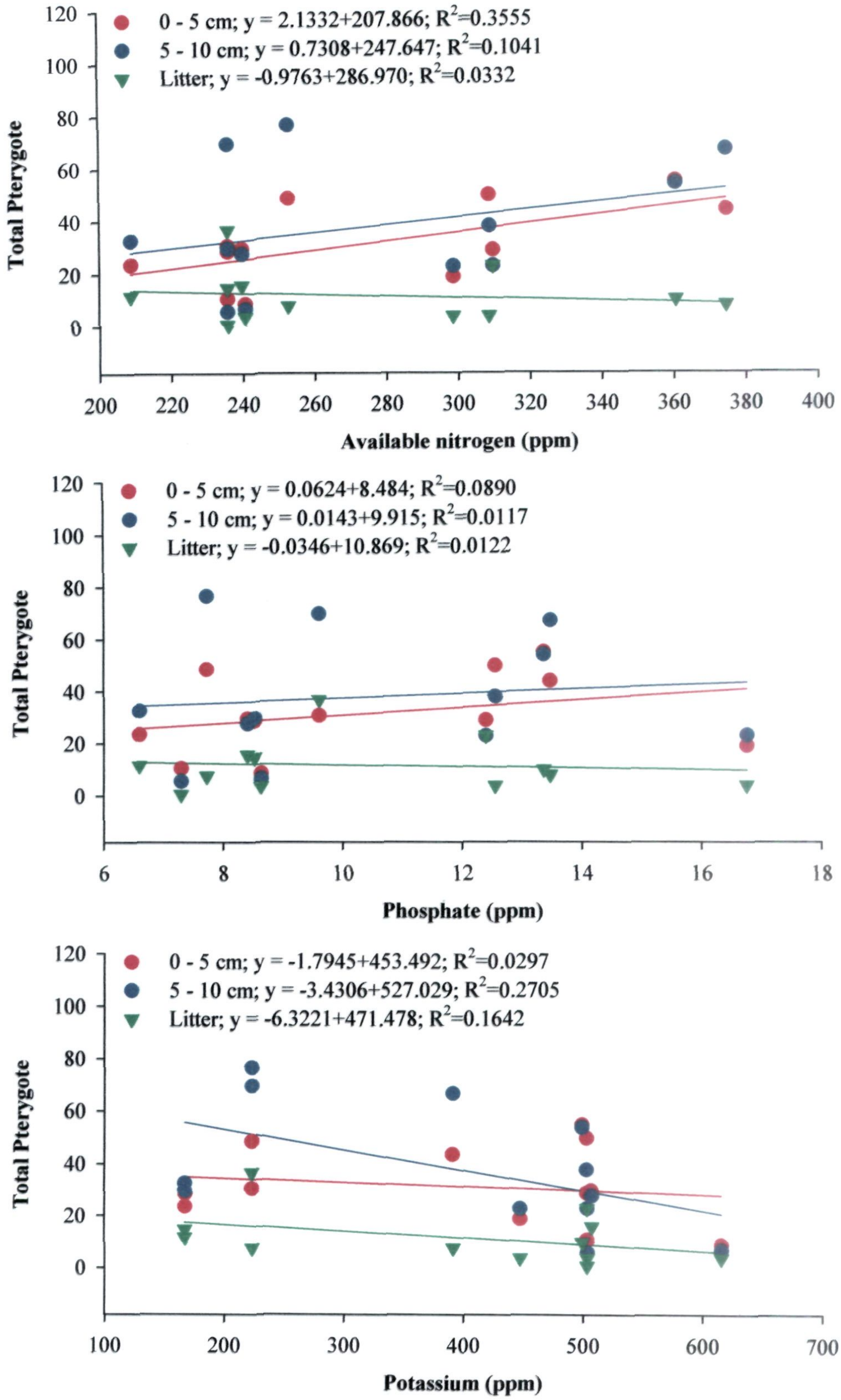


Figure 24c: Regression analysis of total population of pterygote with available nitrogen, phosphate and potassium from the site of Mango Orchards during 2009-10

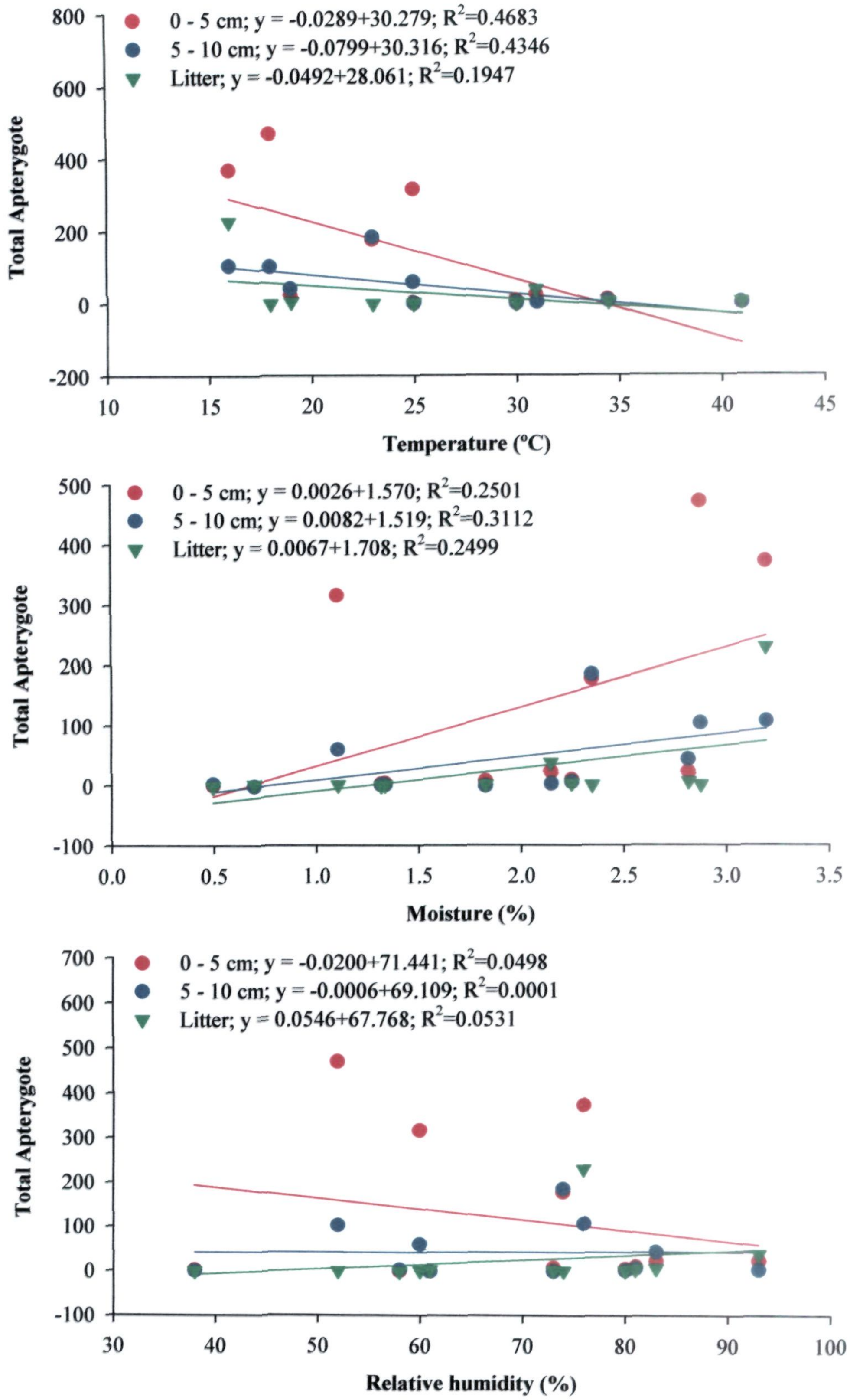


Figure 24d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Mango Orchards during 2009-10

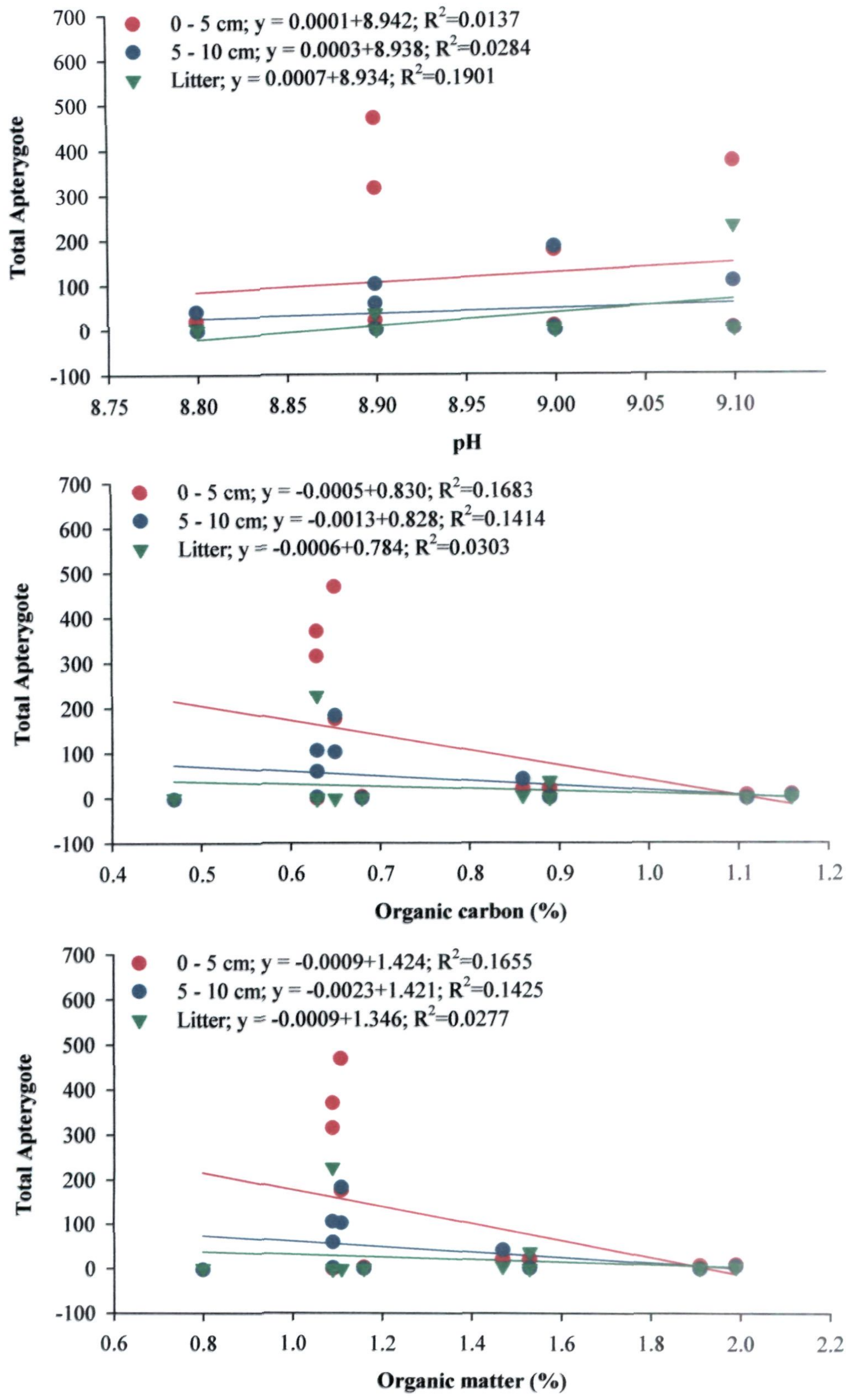


Figure 24e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Mango Orchards during 2009-10

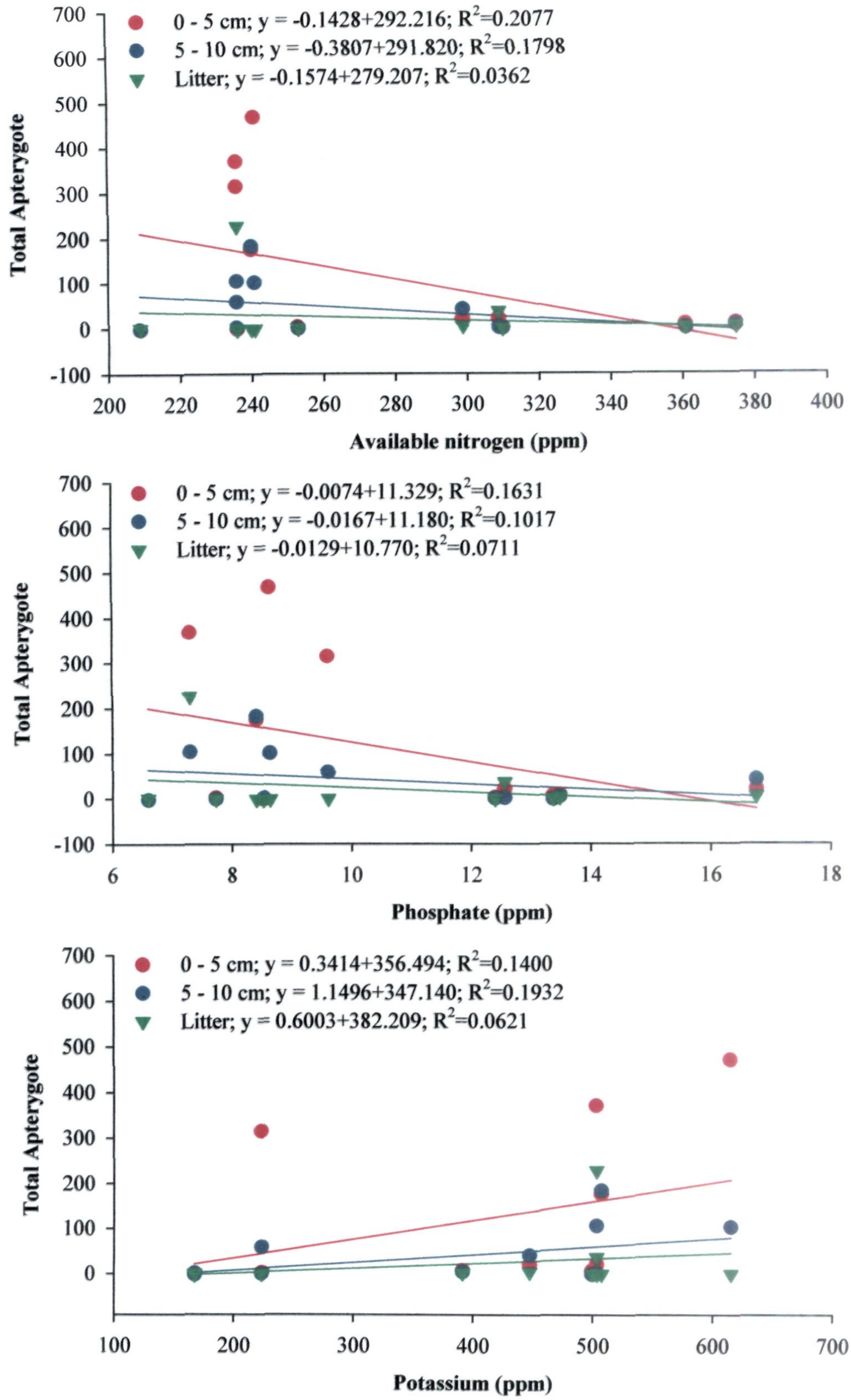


Figure 24f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Mango Orchards during 2009-10

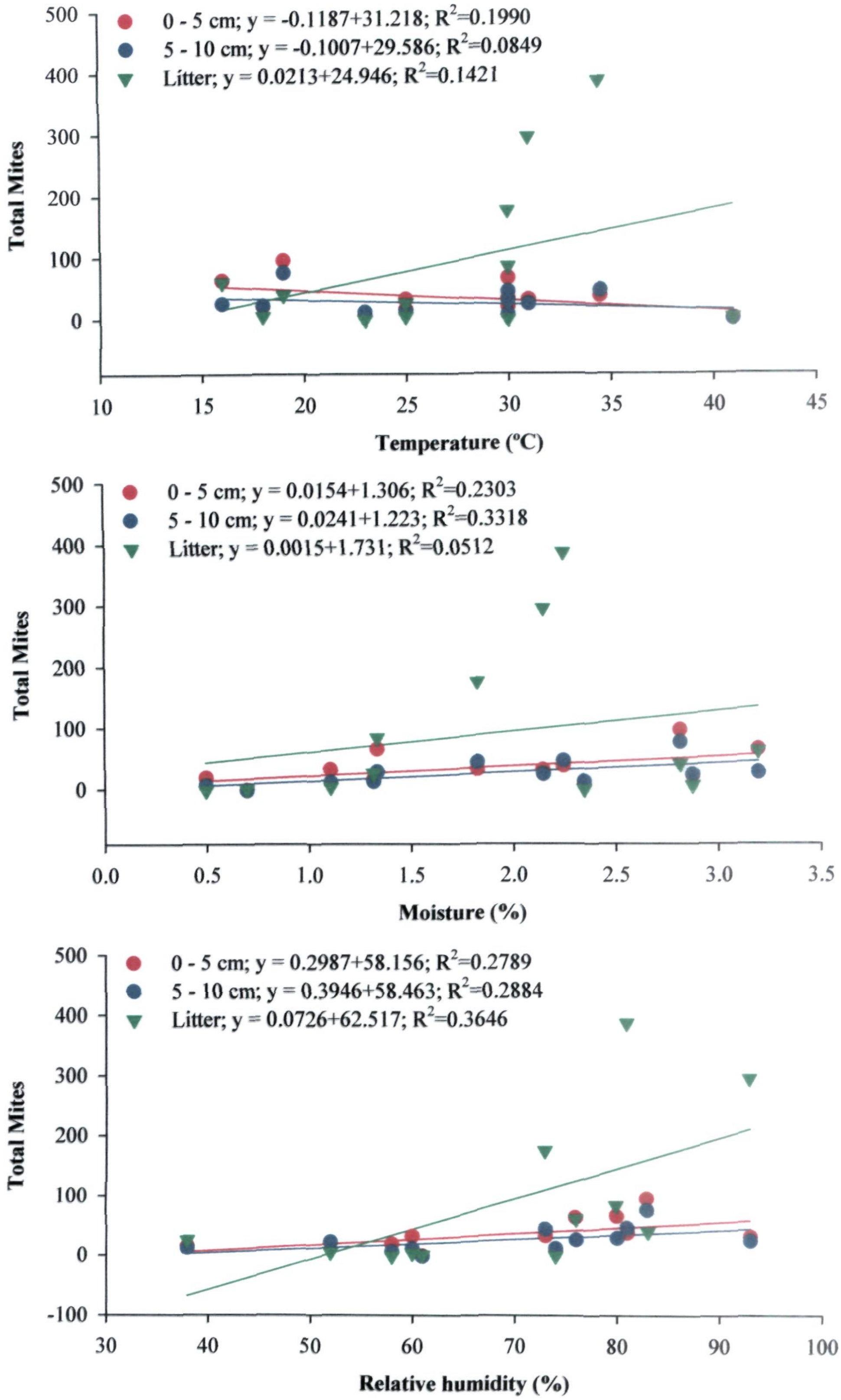


Figure 24g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Mango Orchards during 2009-10

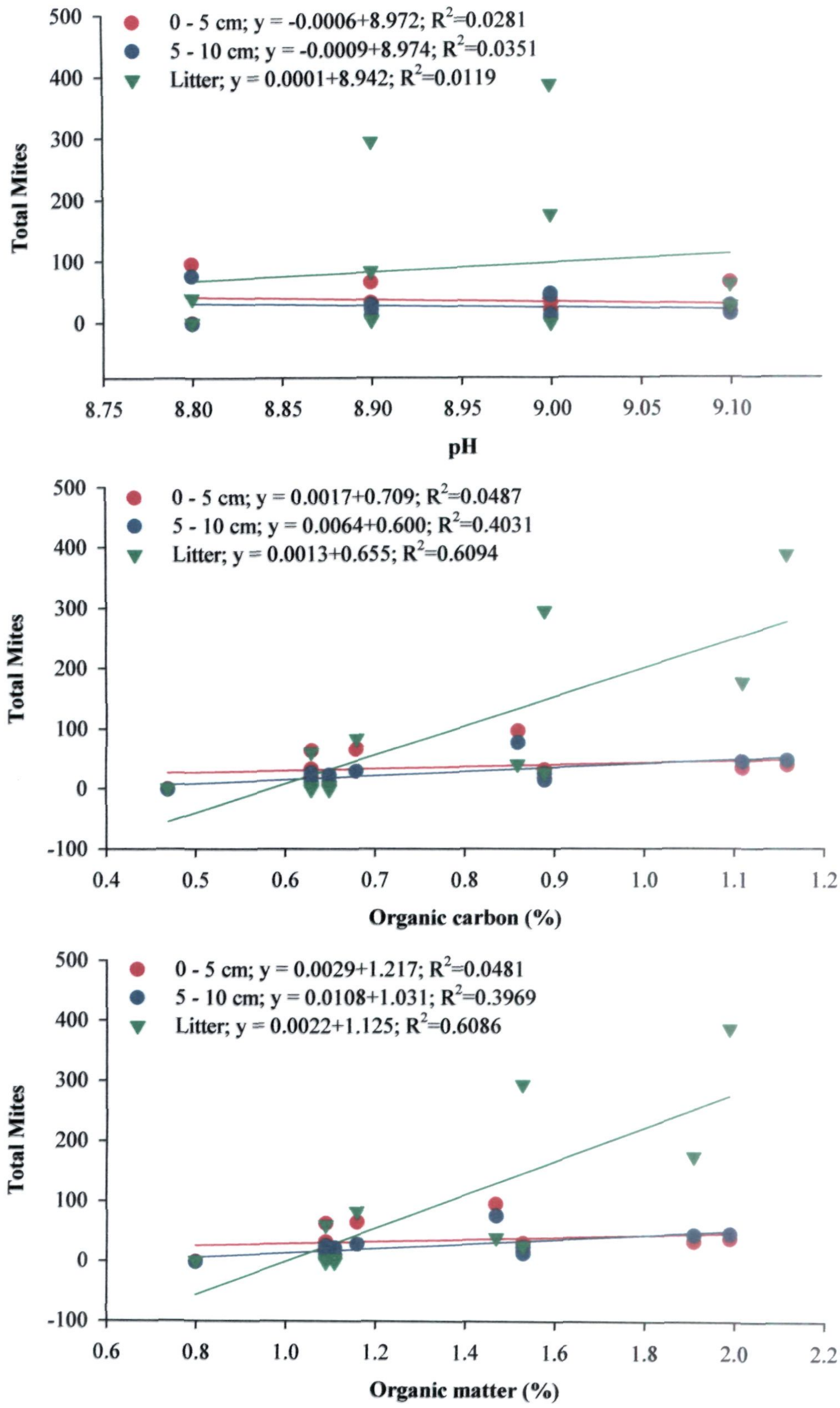


Figure 24h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Mango Orchards during 2009-10

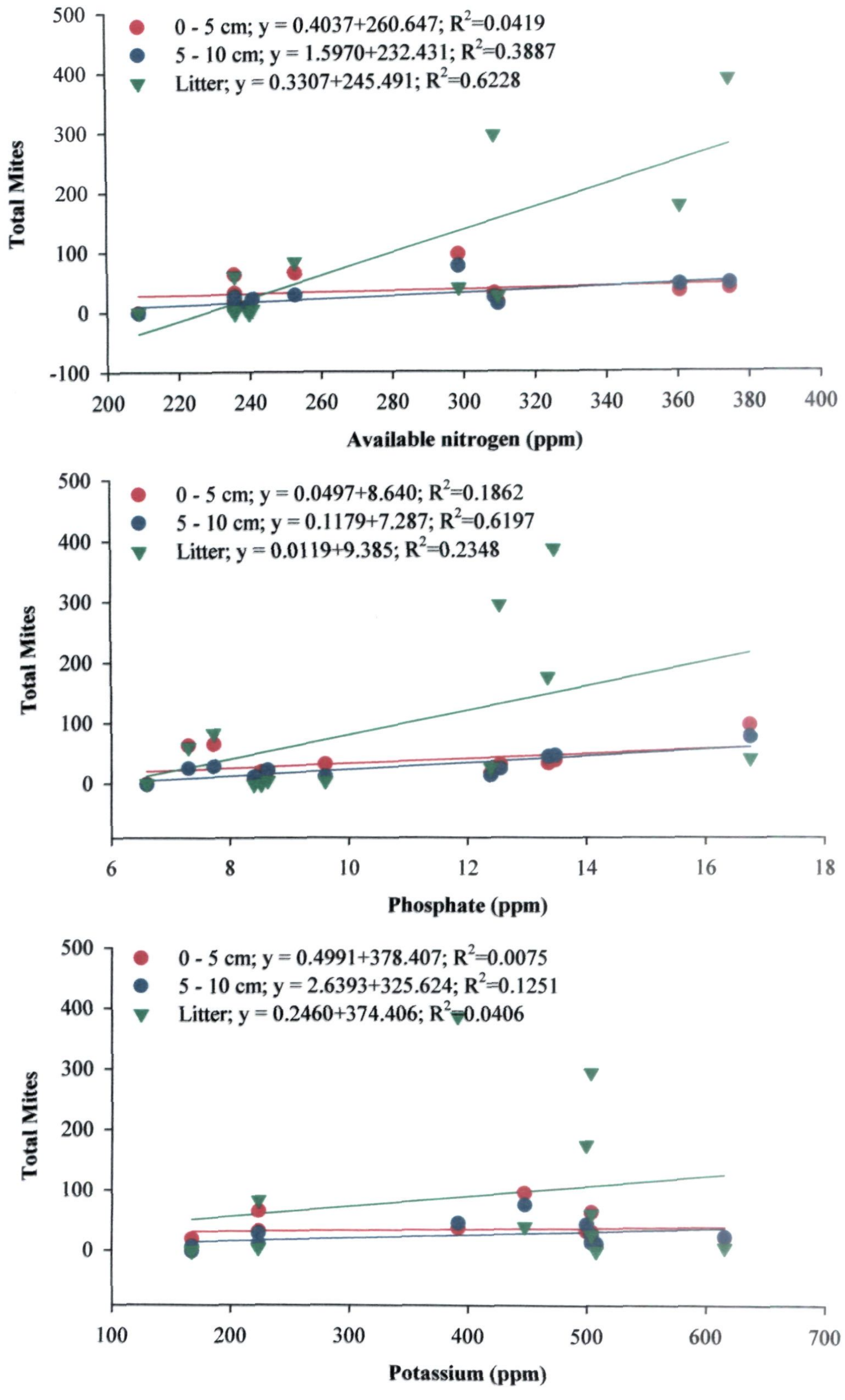


Figure 24i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Mango Orchards during 2009-10

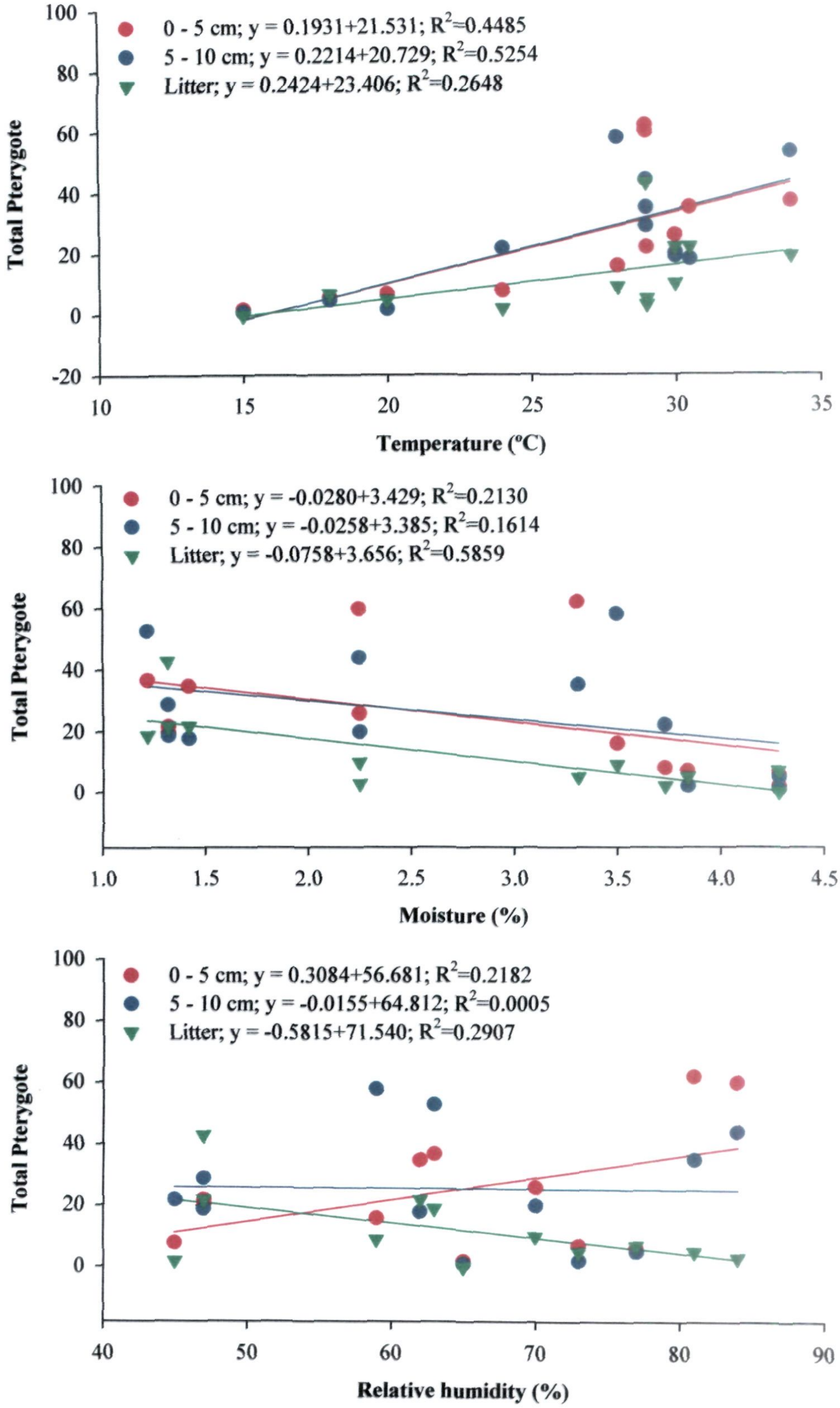


Figure 25a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Teak Plantation during 2008-09

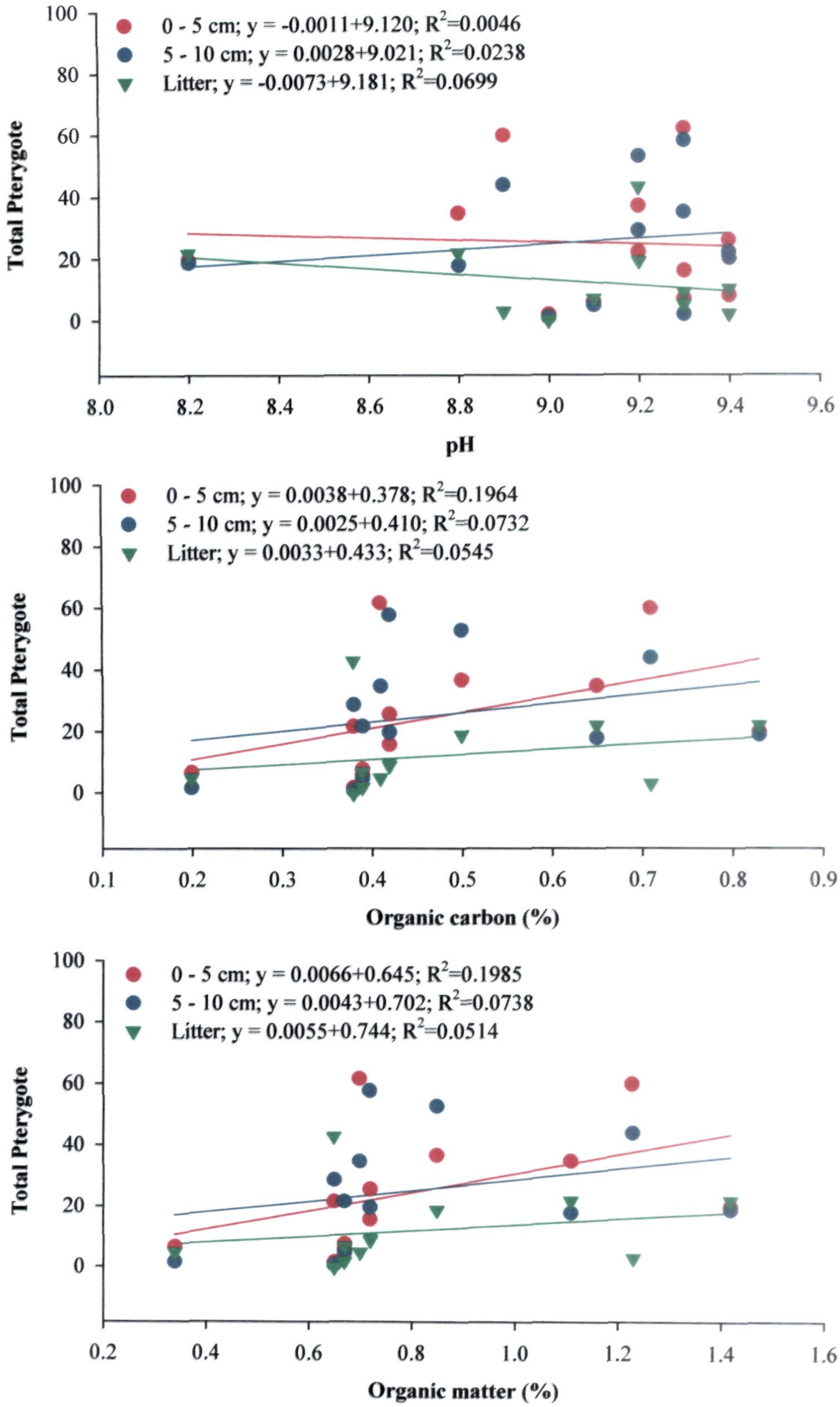


Figure 25b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Teak Plantation during 2008-09

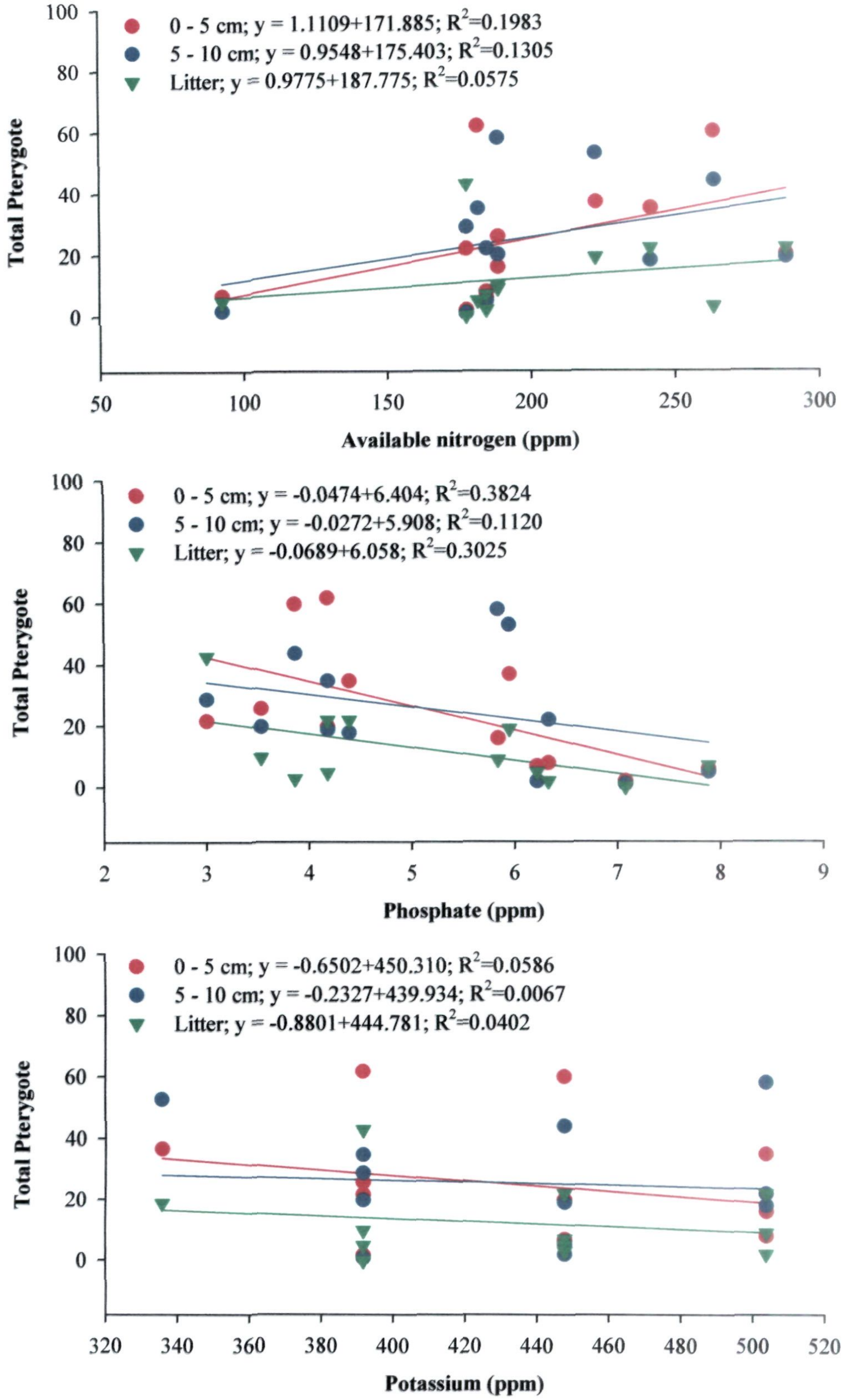


Figure 25c: Regression analysis of total population of pterygote with available nitrogen, phosphate and potassium from the site of Teak Plantation during 2008-09

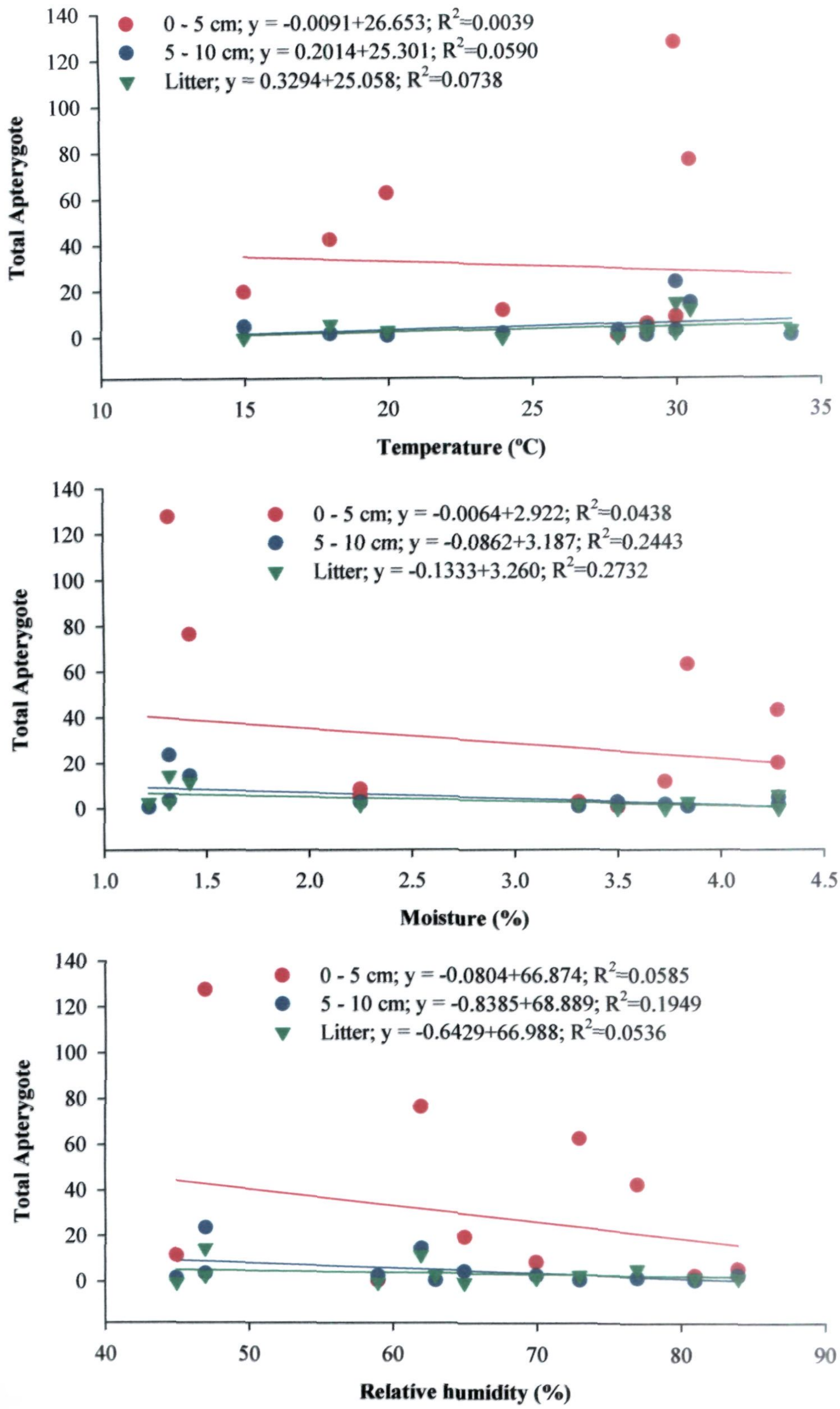


Figure 25d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Teak Plantation during 2008-09

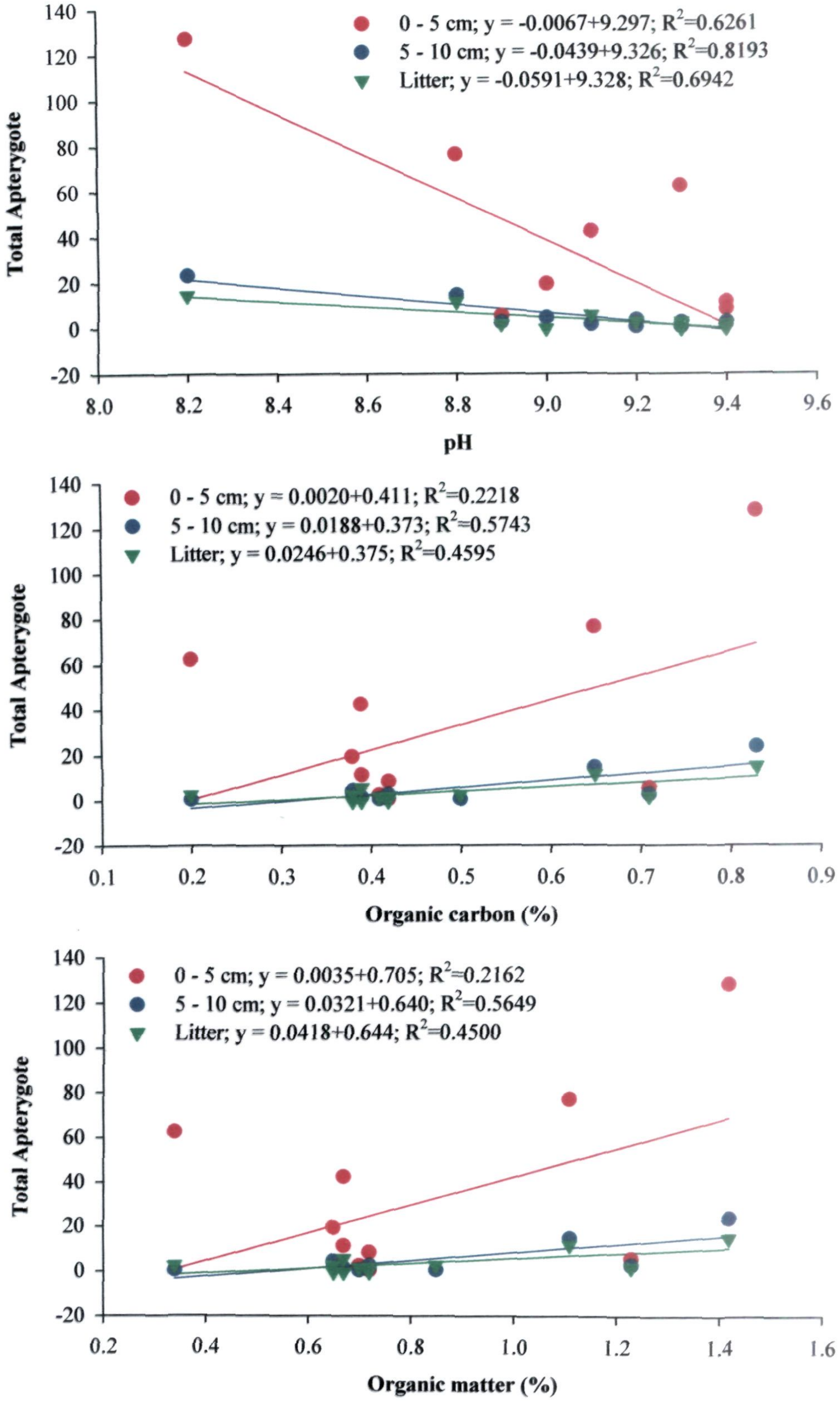
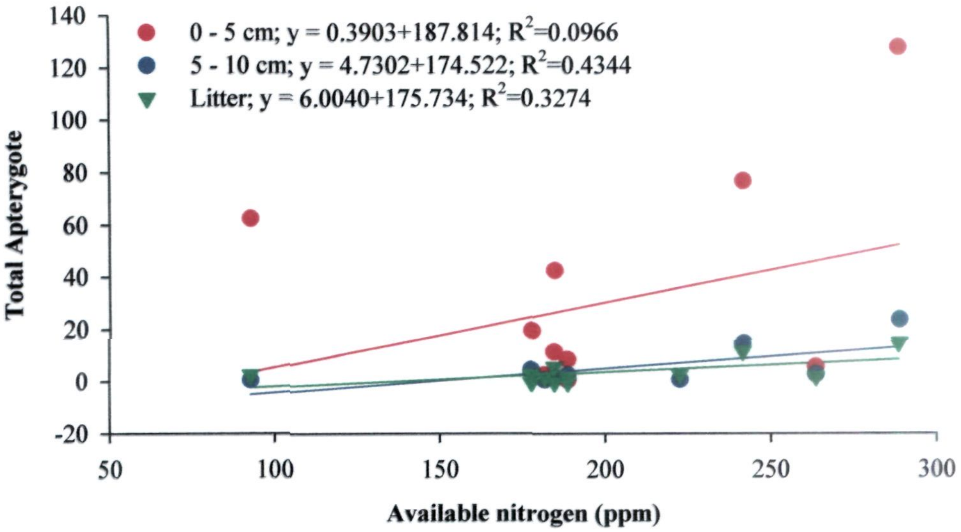
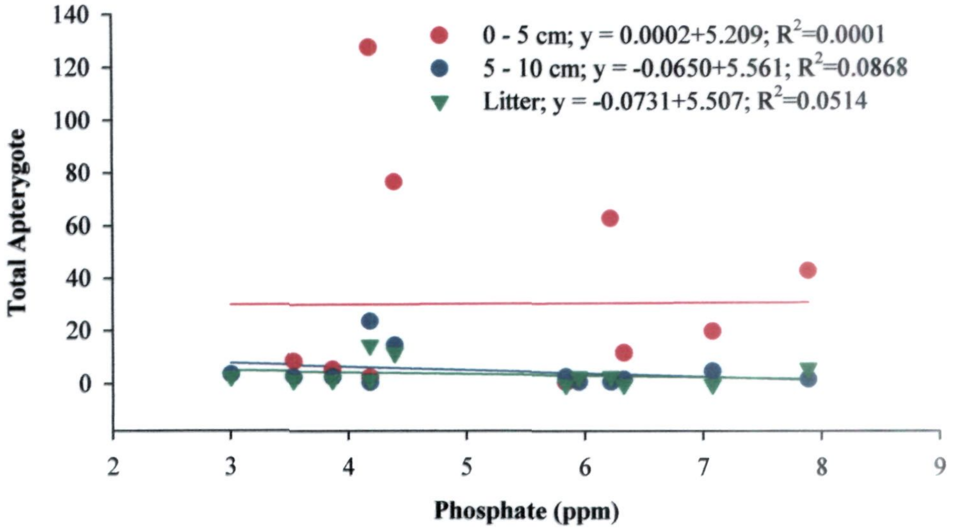


Figure 25e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Teak Plantation during 2008-09





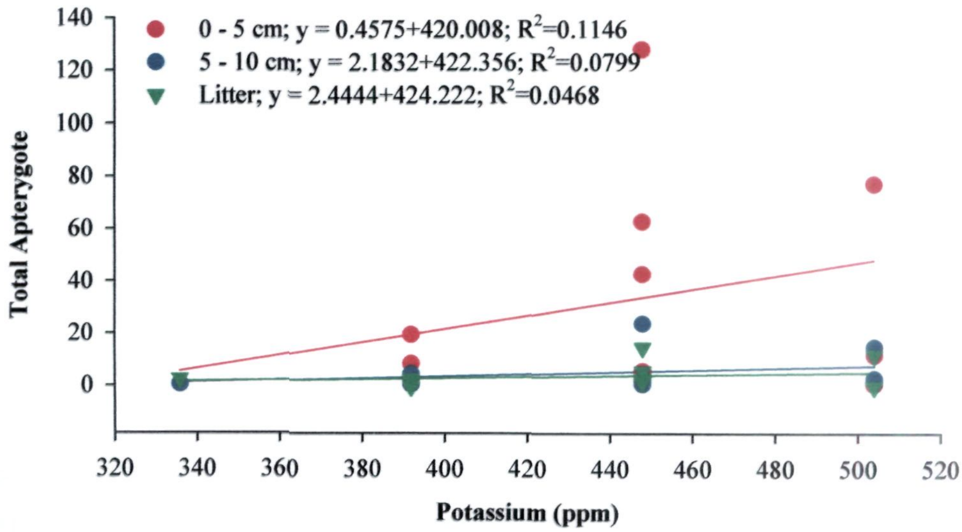


Figure 25f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Teak Plantation during 2008-09

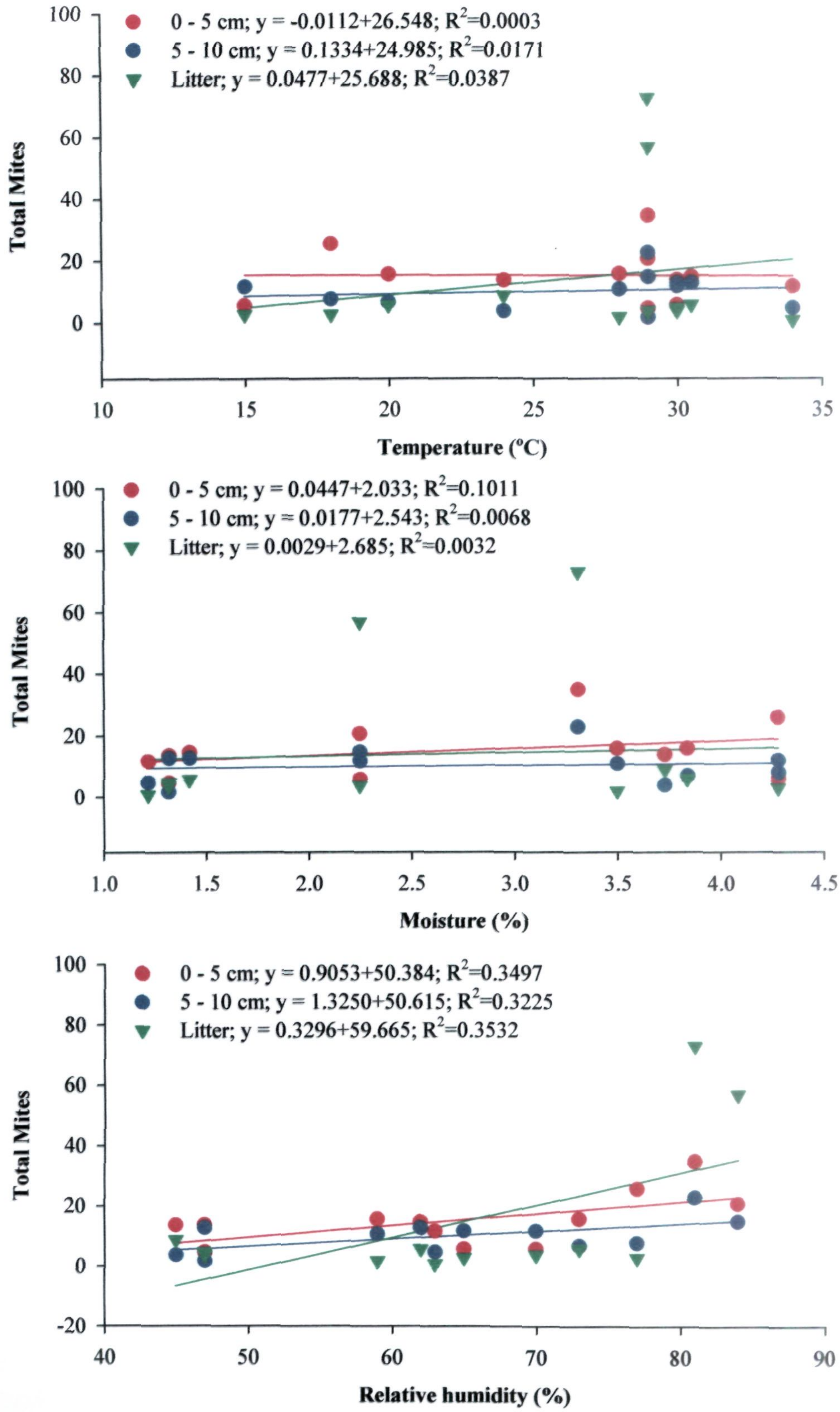


Figure 25g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Teak Plantation during 2008-09

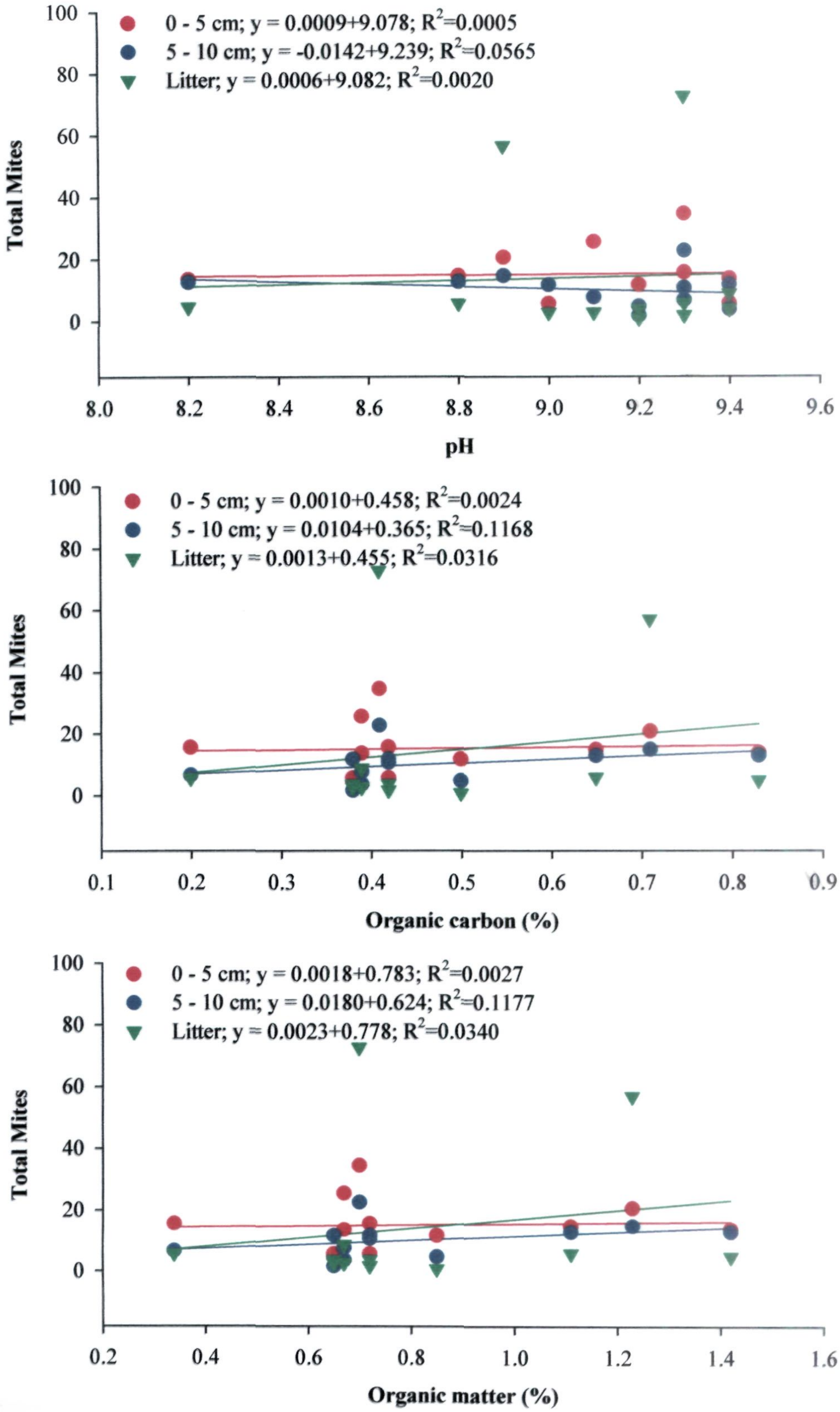


Figure 25h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Teak Plantation during 2008-09

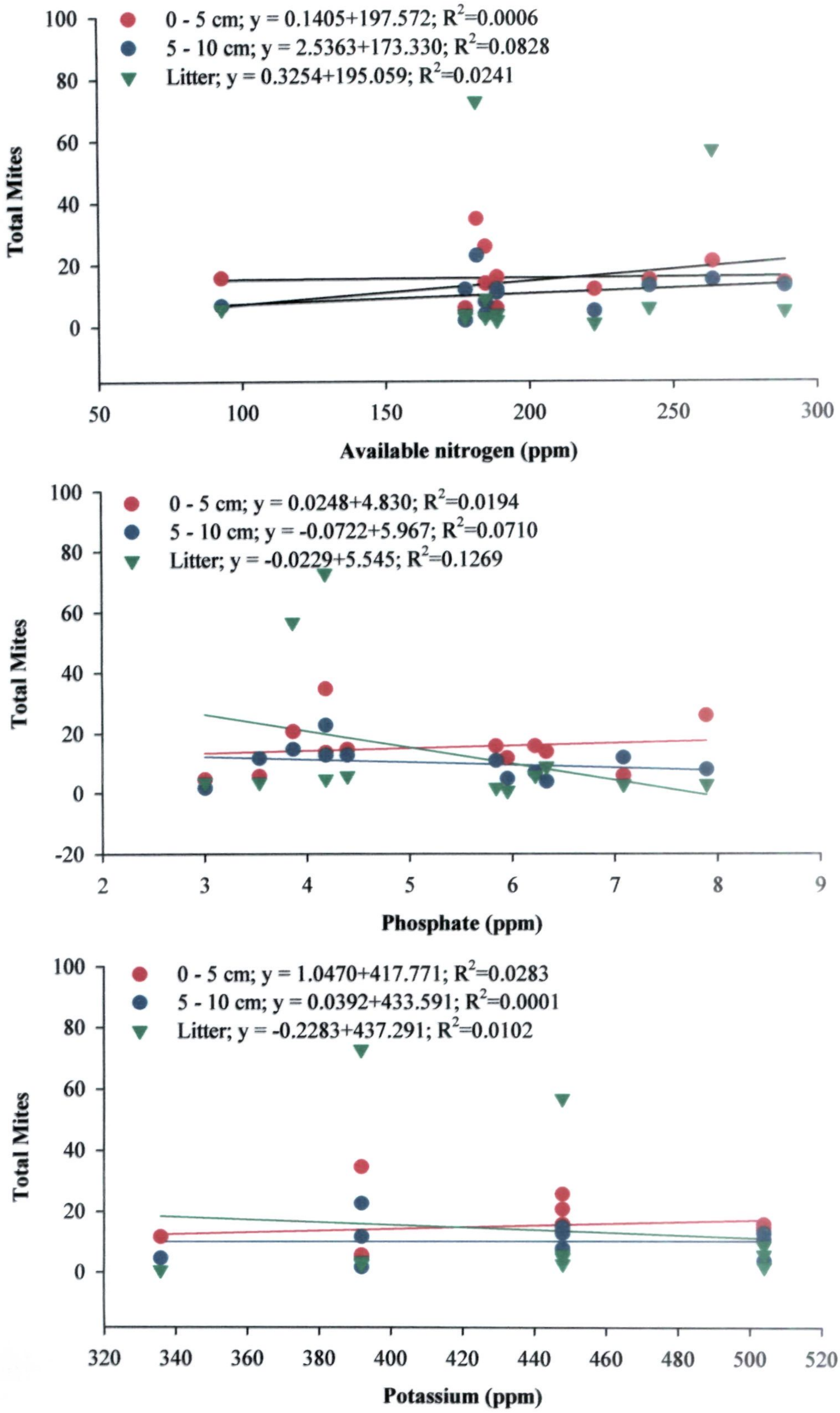


Figure 25i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Teak Plantation during 2008-09

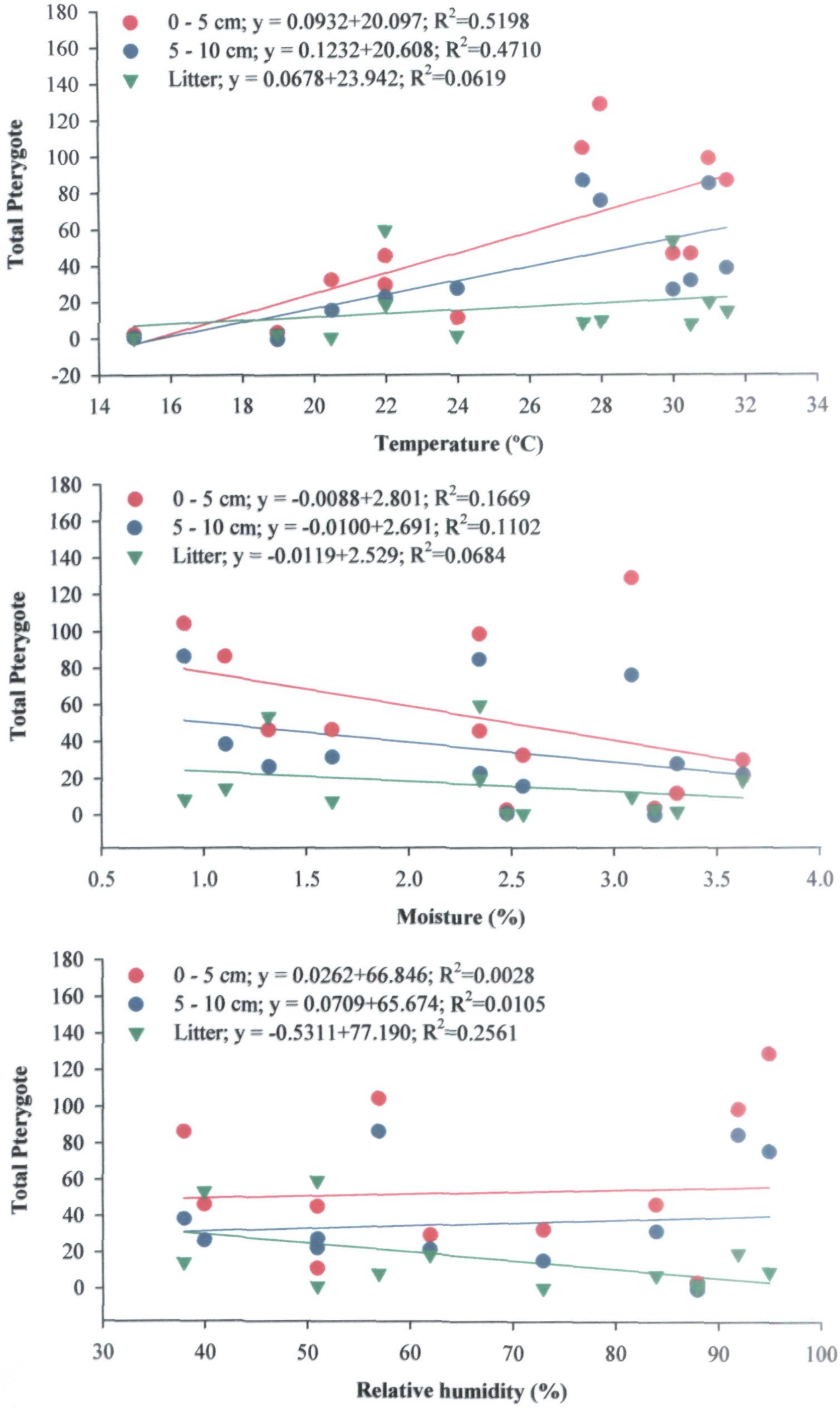


Figure 26a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Teak Plantation during 2009-10

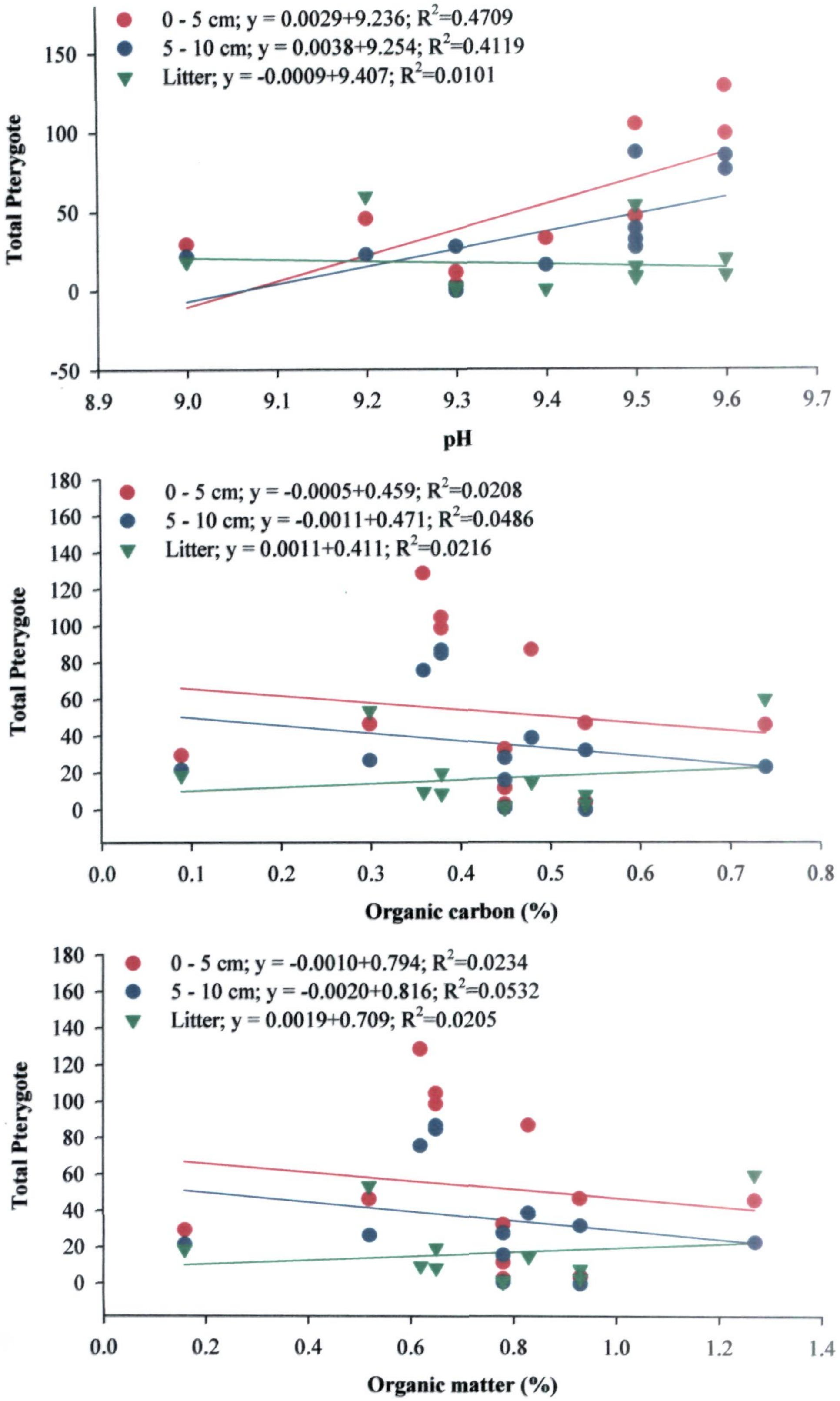


Figure 26b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Teak Plantation during 2009-10

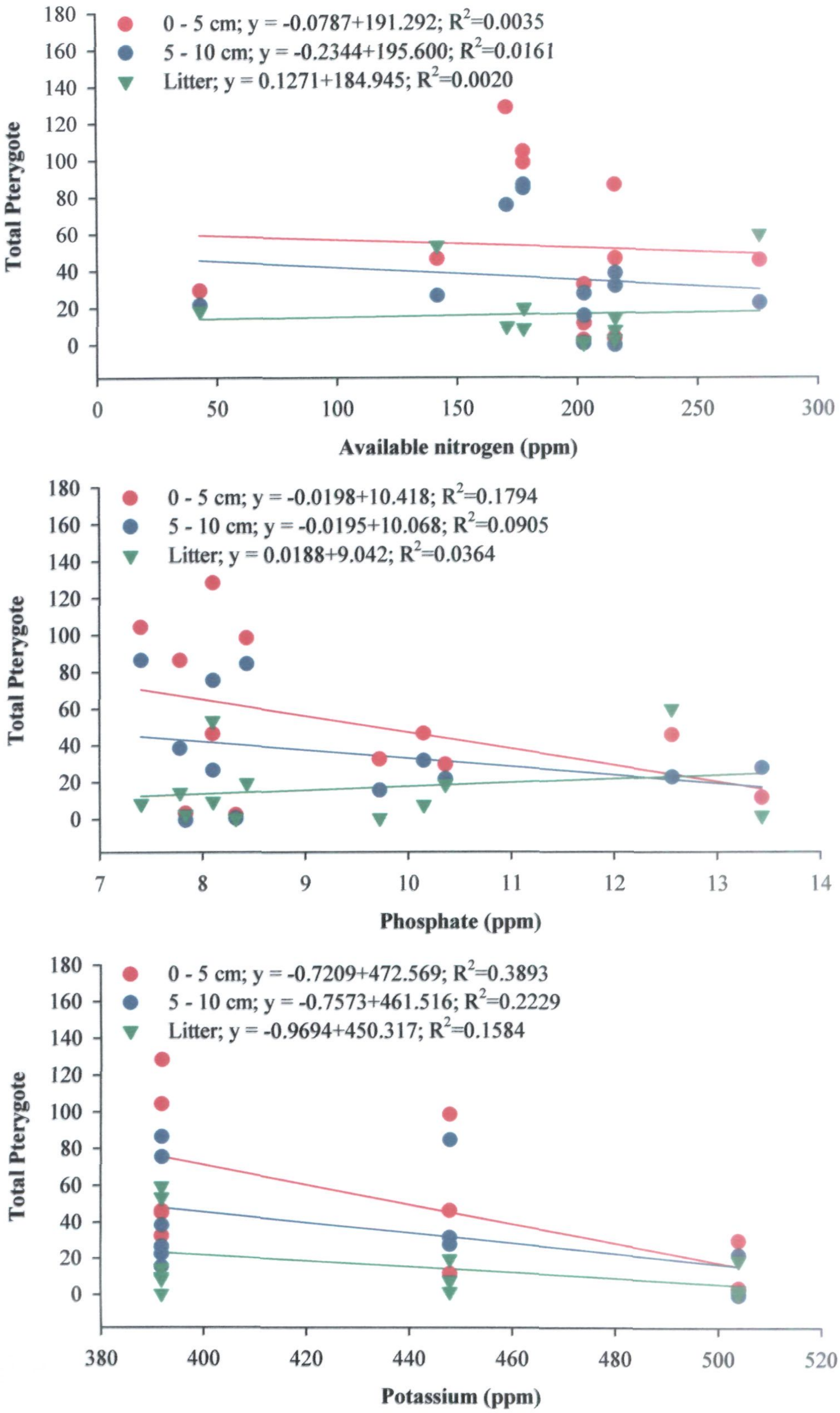


Figure 26c: Regression analysis of total population of pterygote with available nitrogen, phosphate and potassium from the site of Teak Plantation during 2009-10

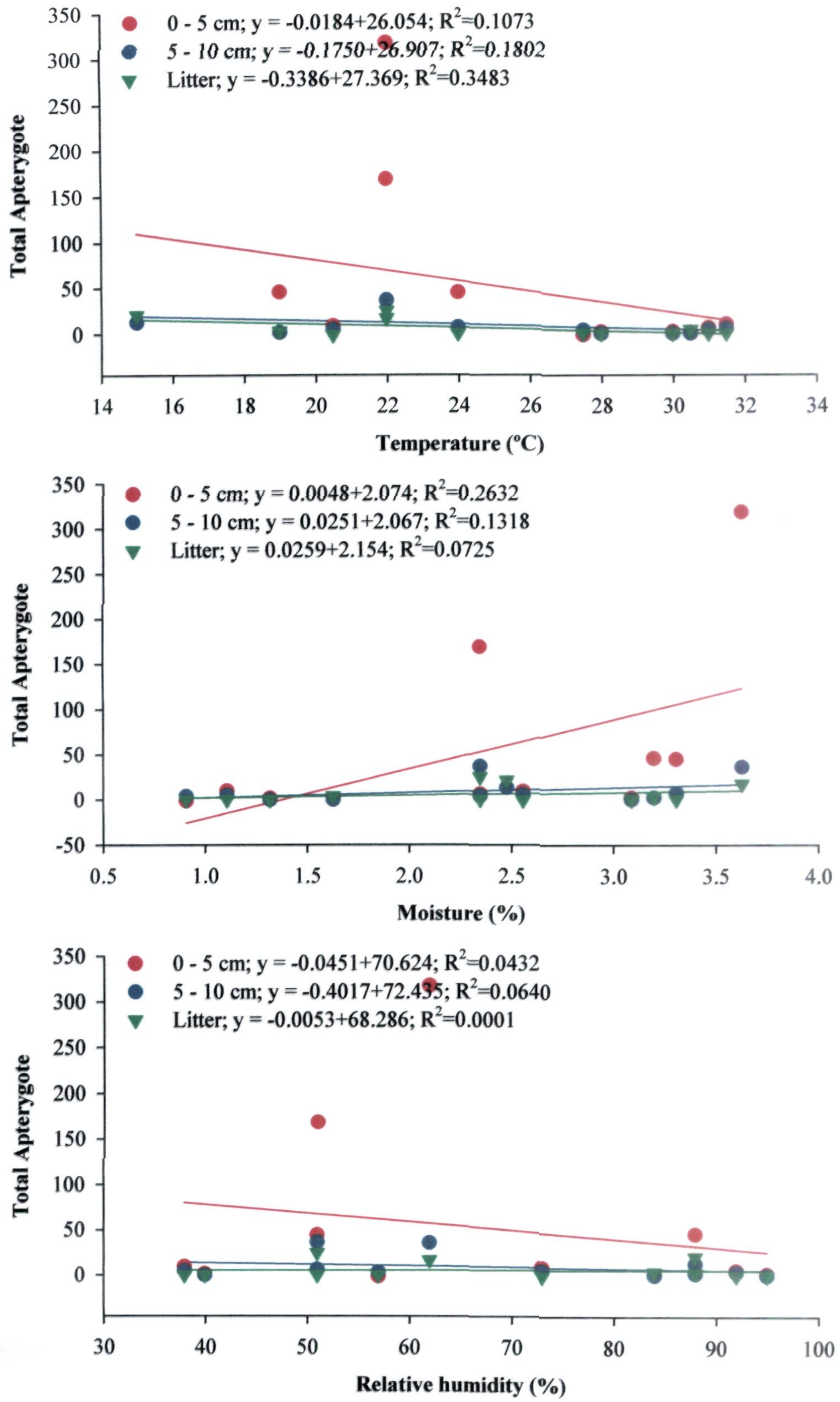


Figure 26d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Teak Plantation during 2009-10

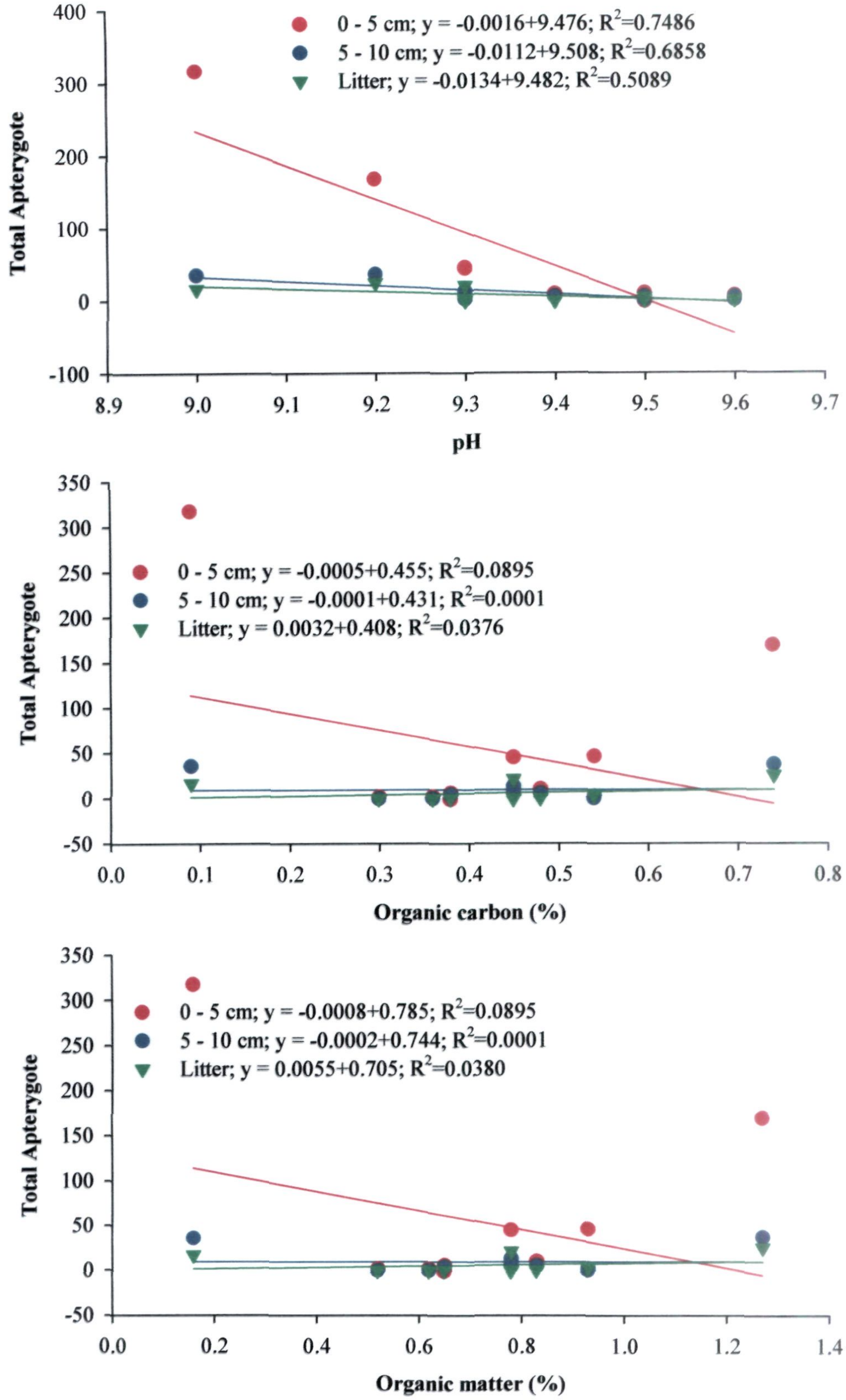


Figure 26e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Teak Plantation during 2009-10

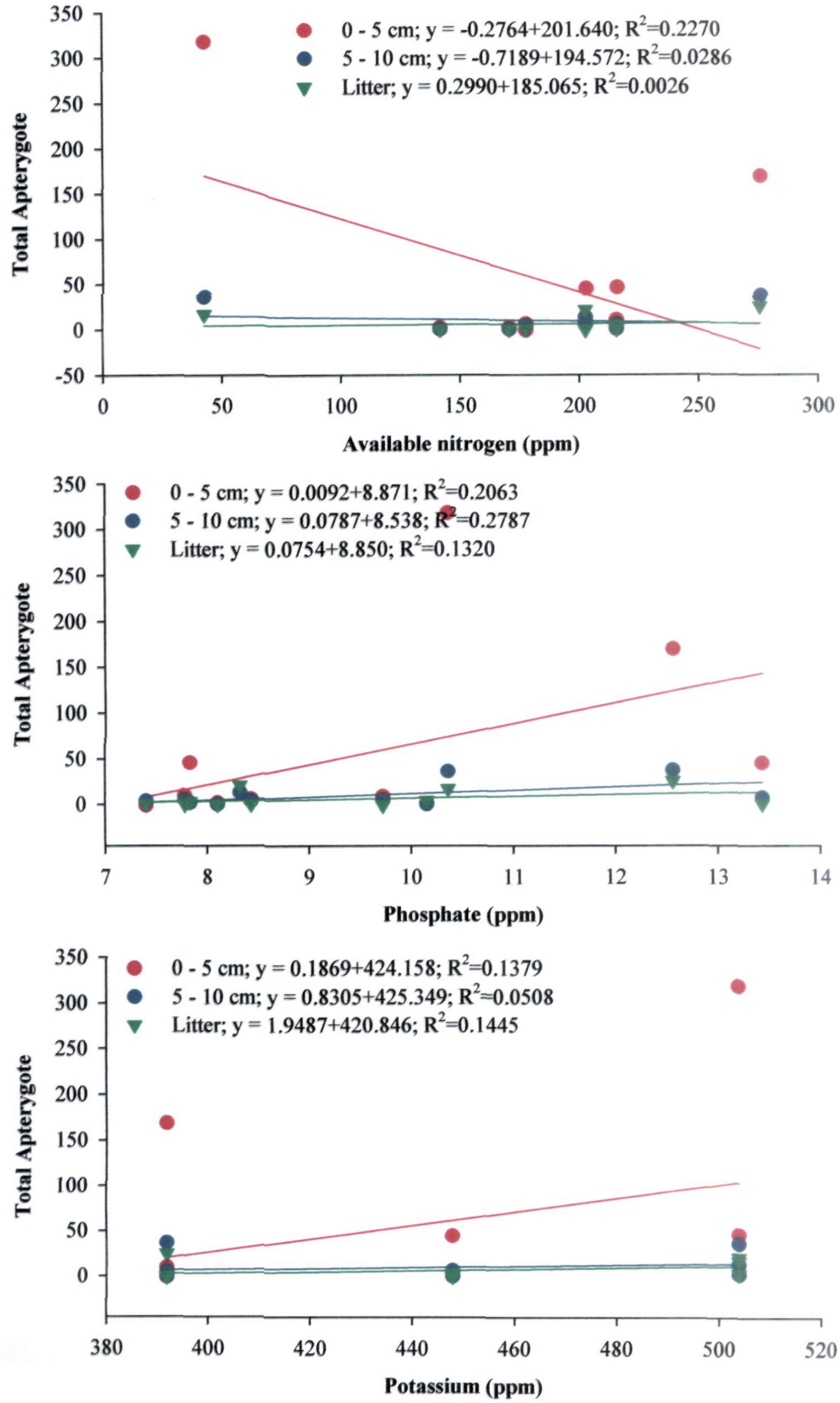


Figure 26f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Teak Plantation during 2009-10

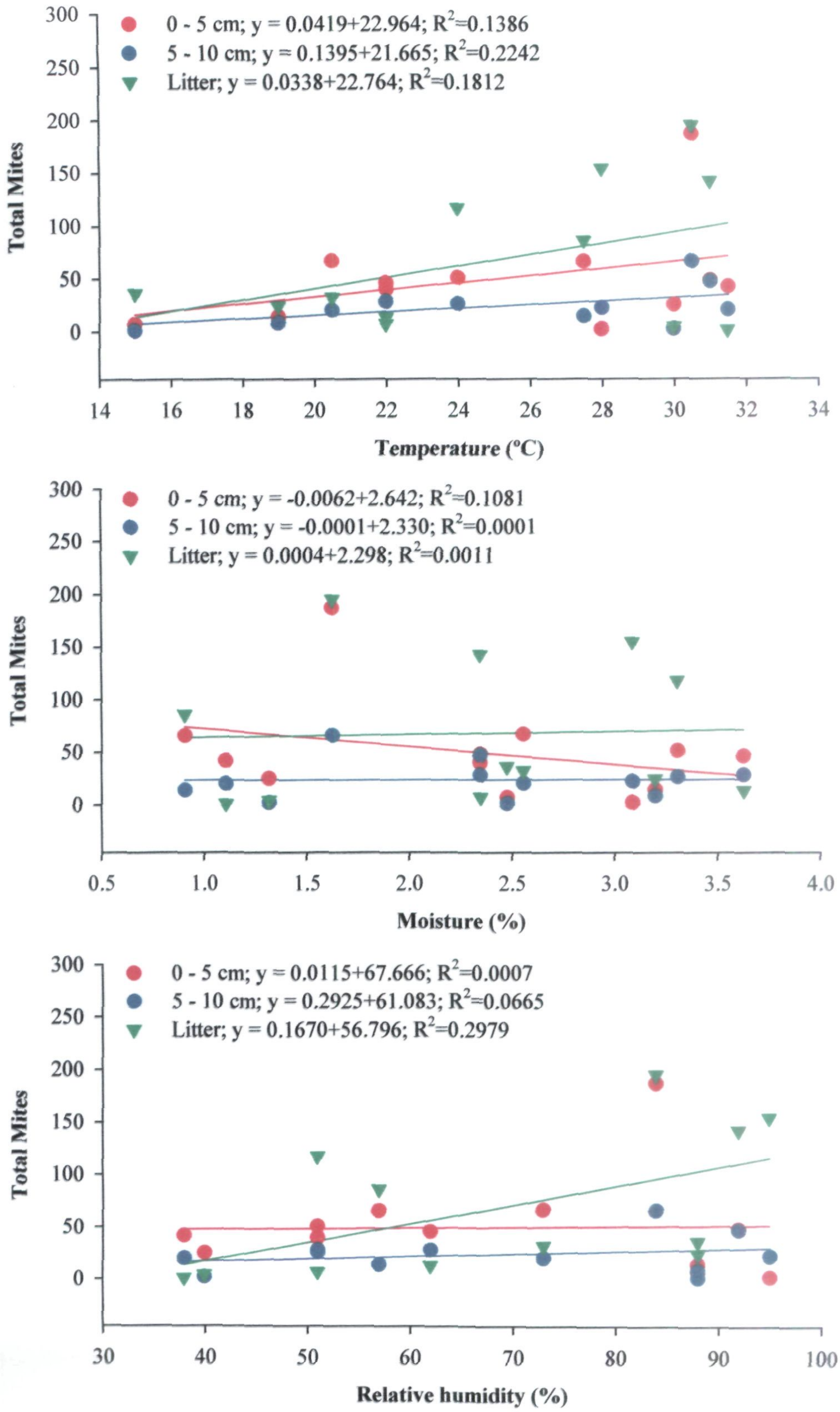


Figure 26g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Teak Plantation during 2009-10

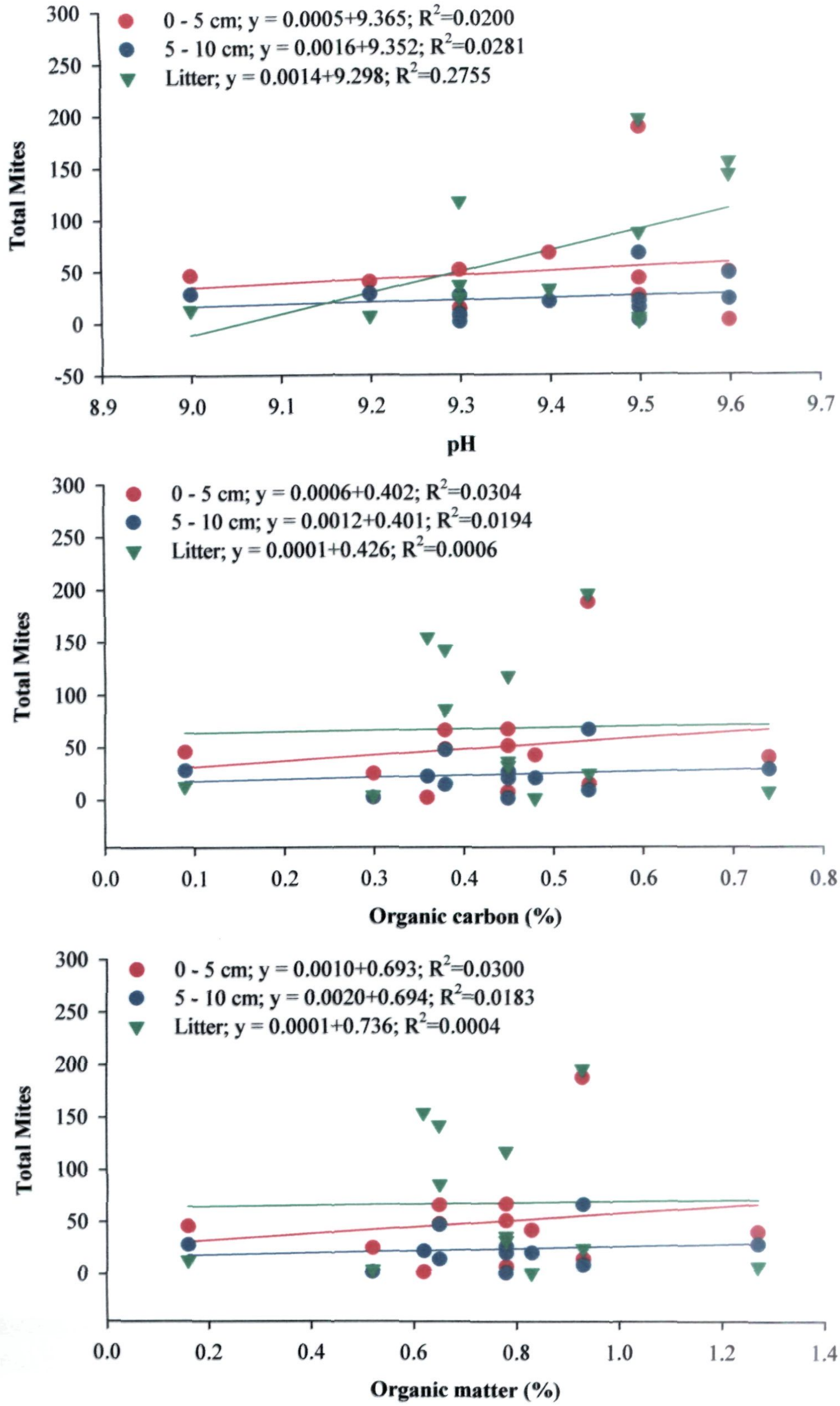


Figure 26h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Teak Plantation during 2009-10

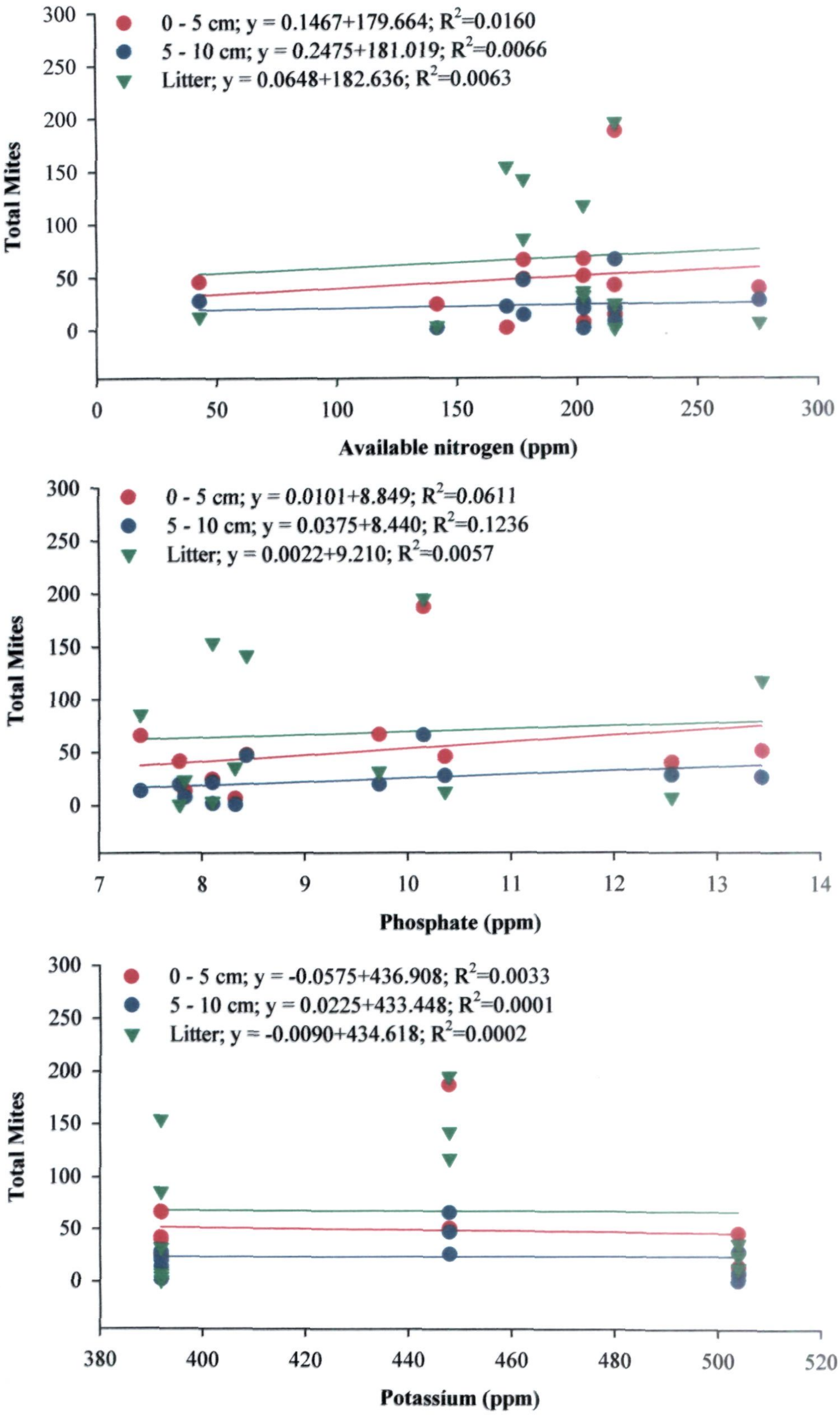


Figure 26i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Teak Plantation during 2009-10

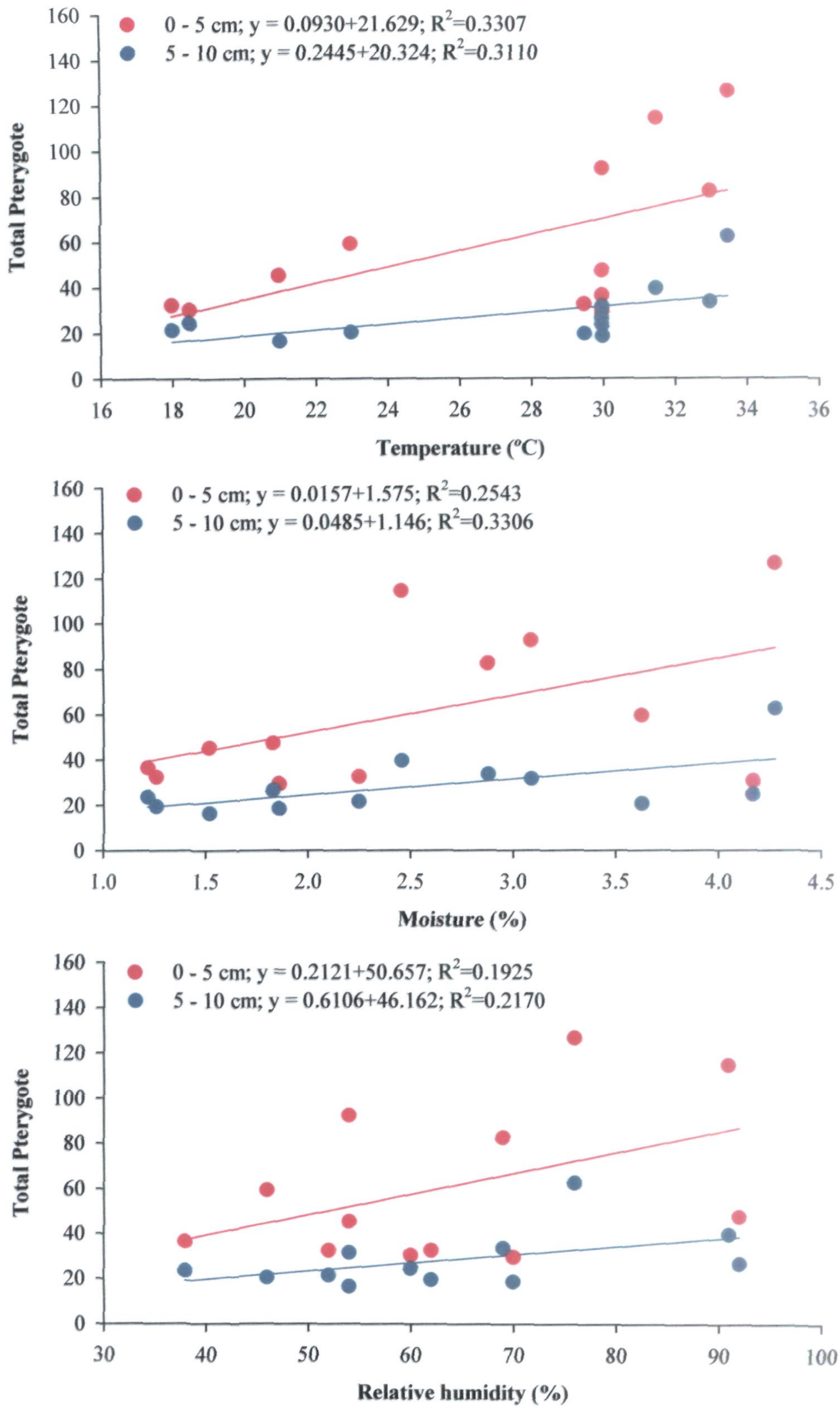


Figure 27a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Unarable Land during 2008-09

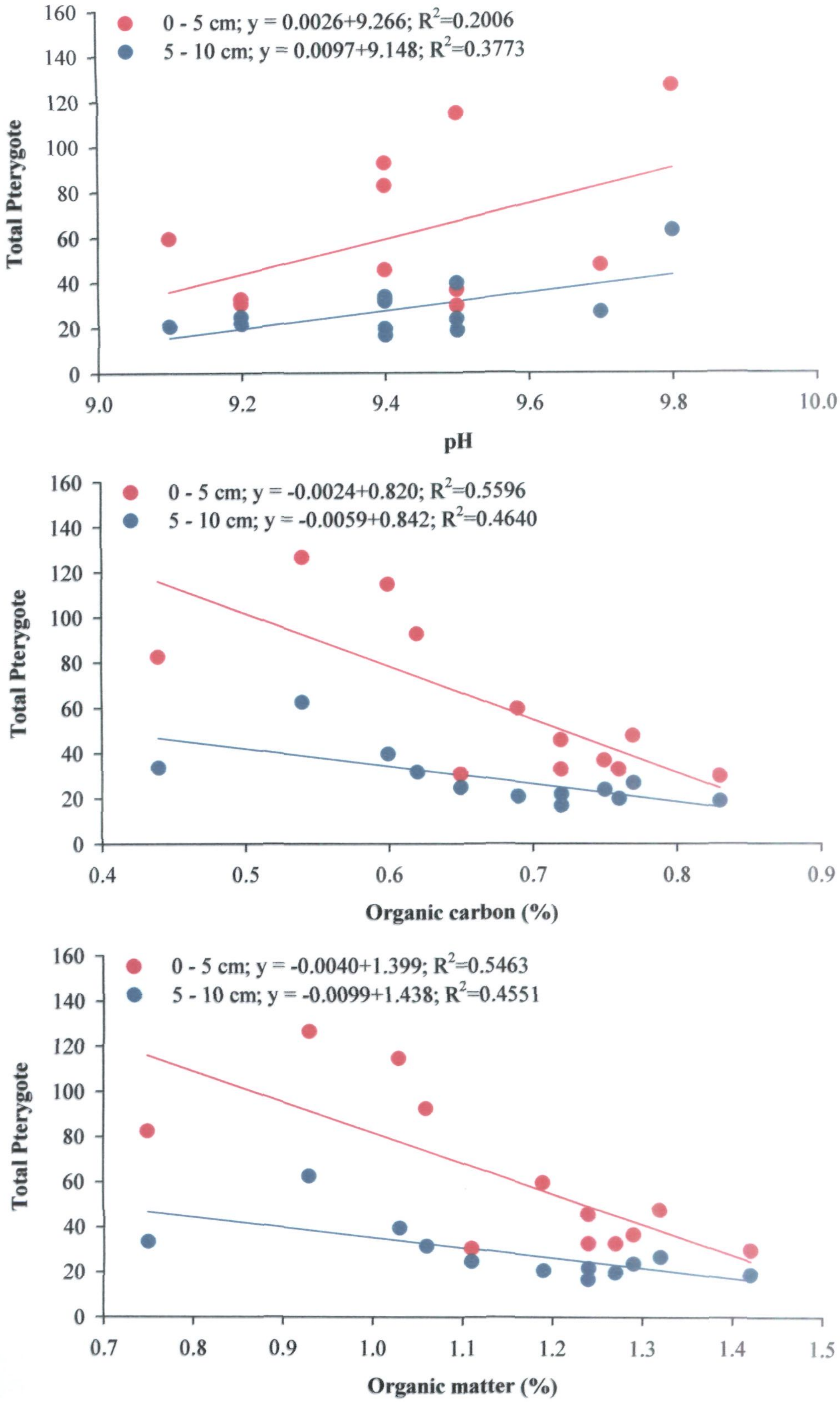


Figure 27b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Unarable Land during 2008-09

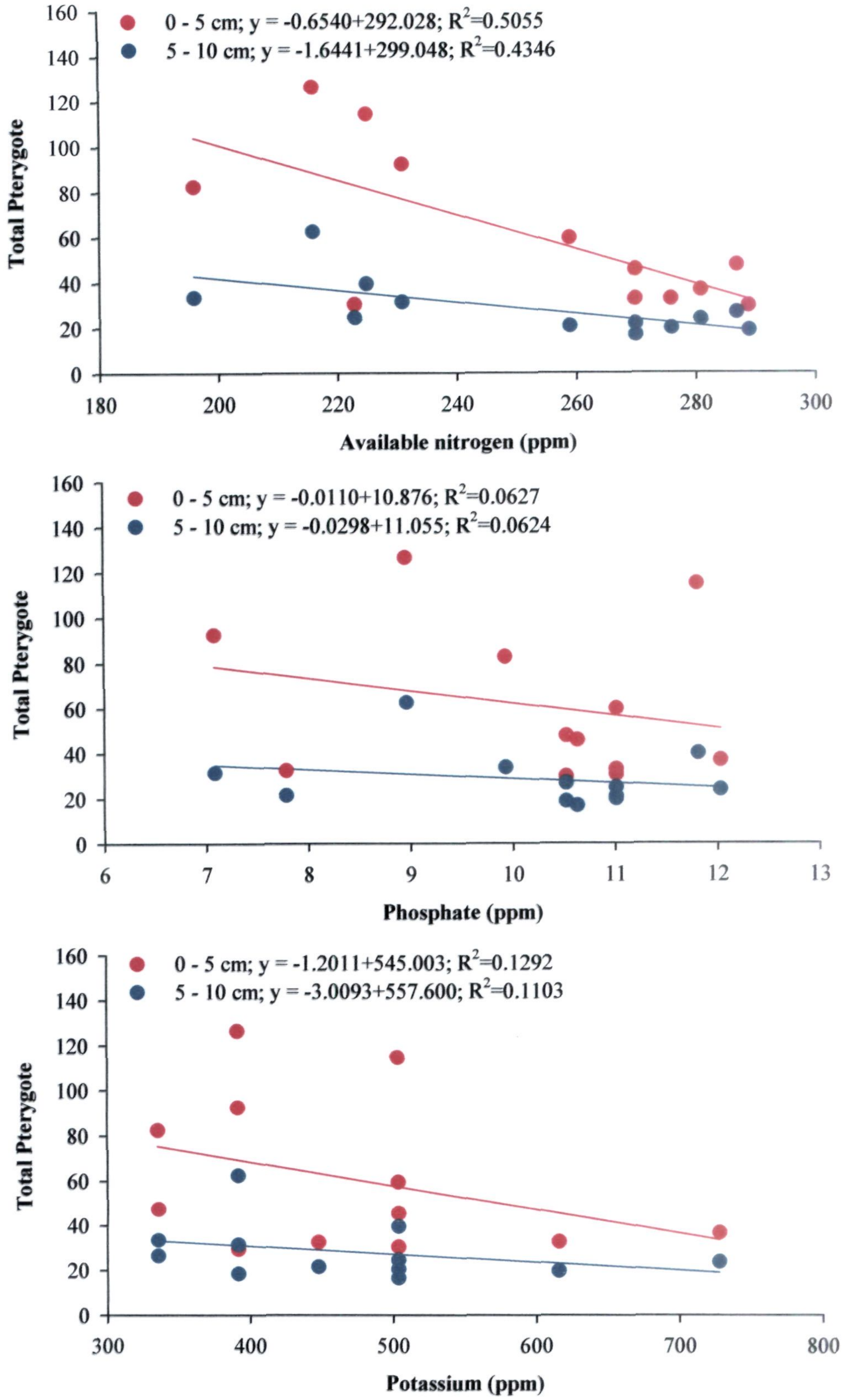


Figure 27c: Regression analysis of total population of pterygote with available nitrogen, phosphate and potassium from the site of Unarable Land during 2008-09

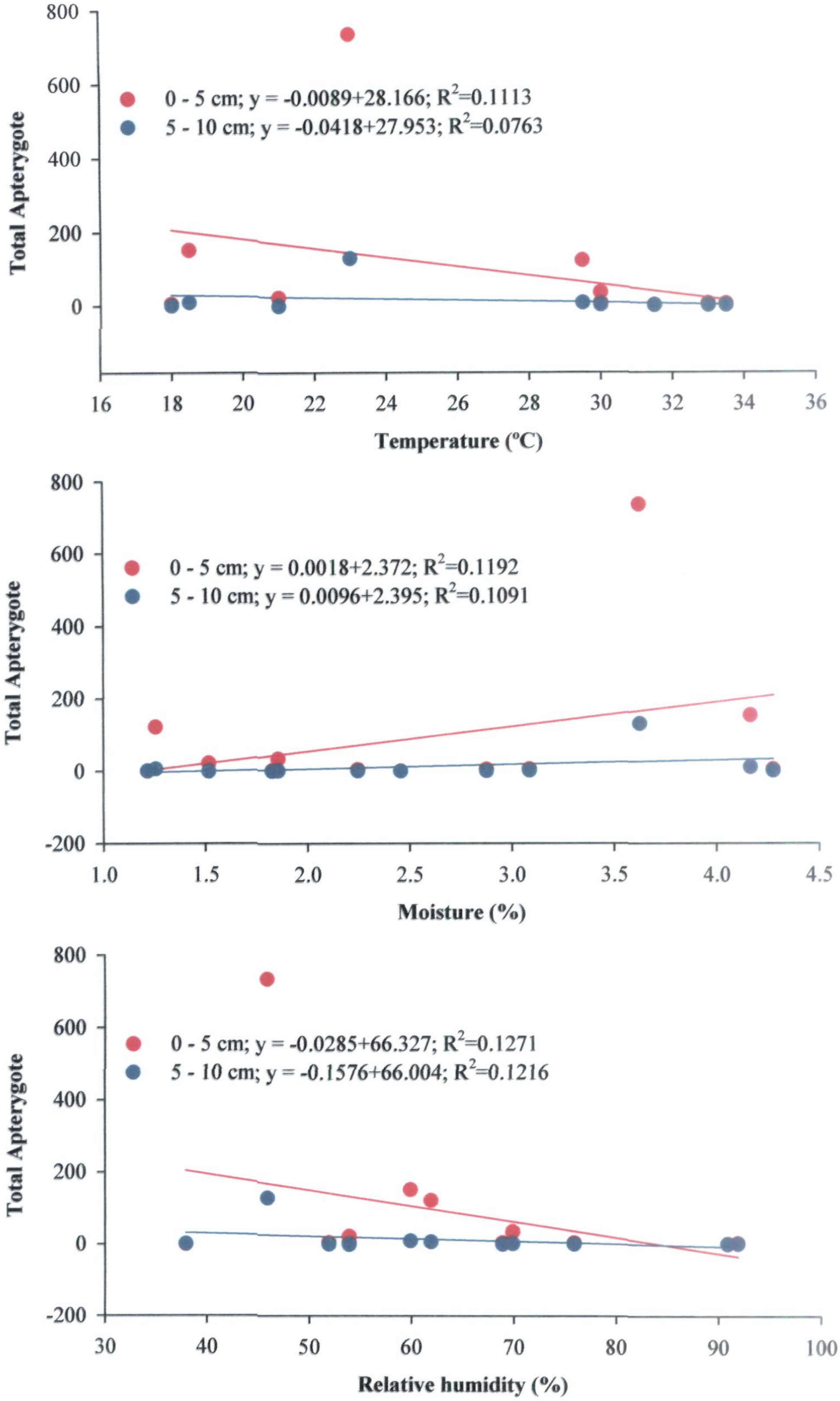


Figure 27d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Unarable Land during 2008-09

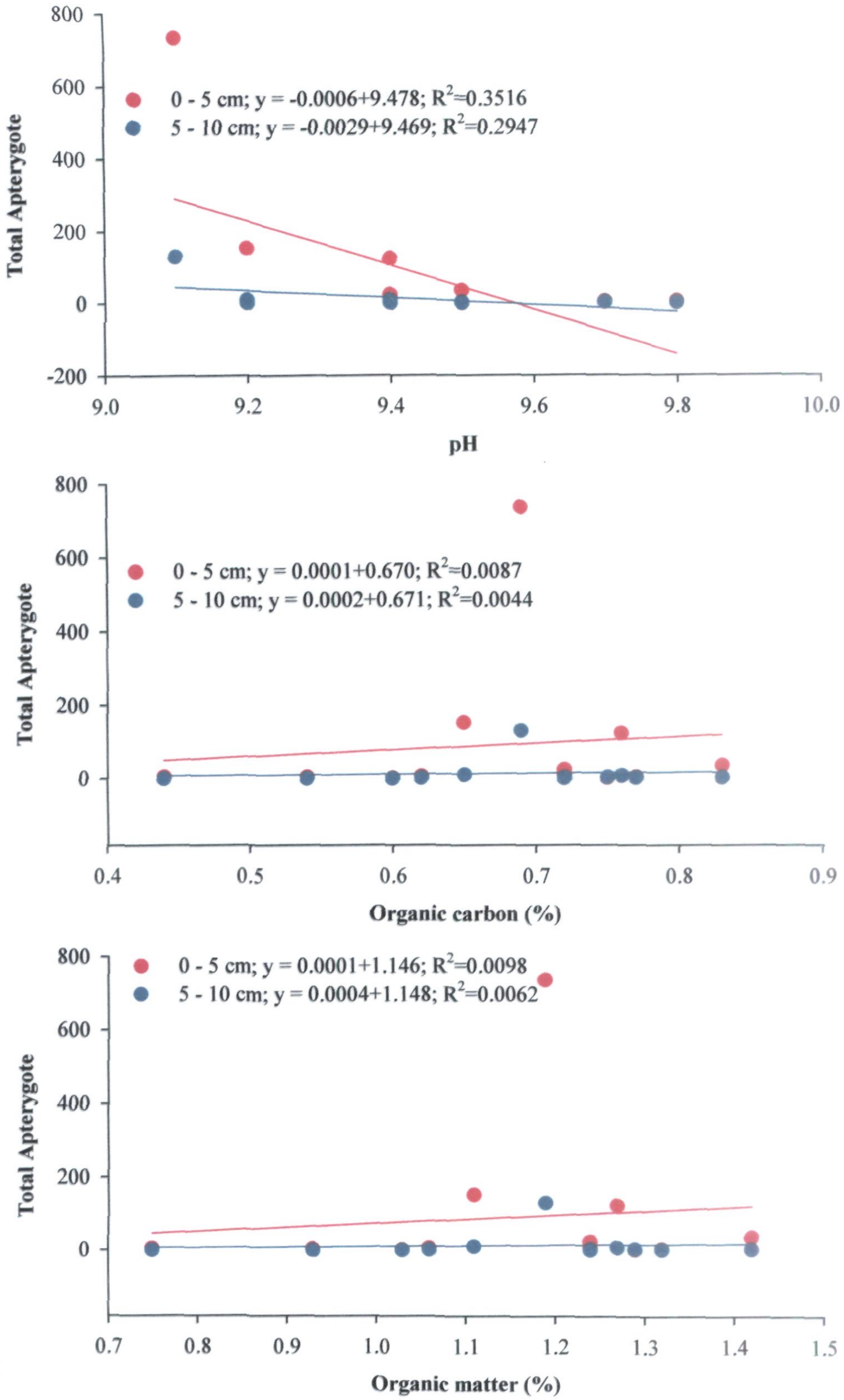


Figure 27e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Unarable Land during 2008-09

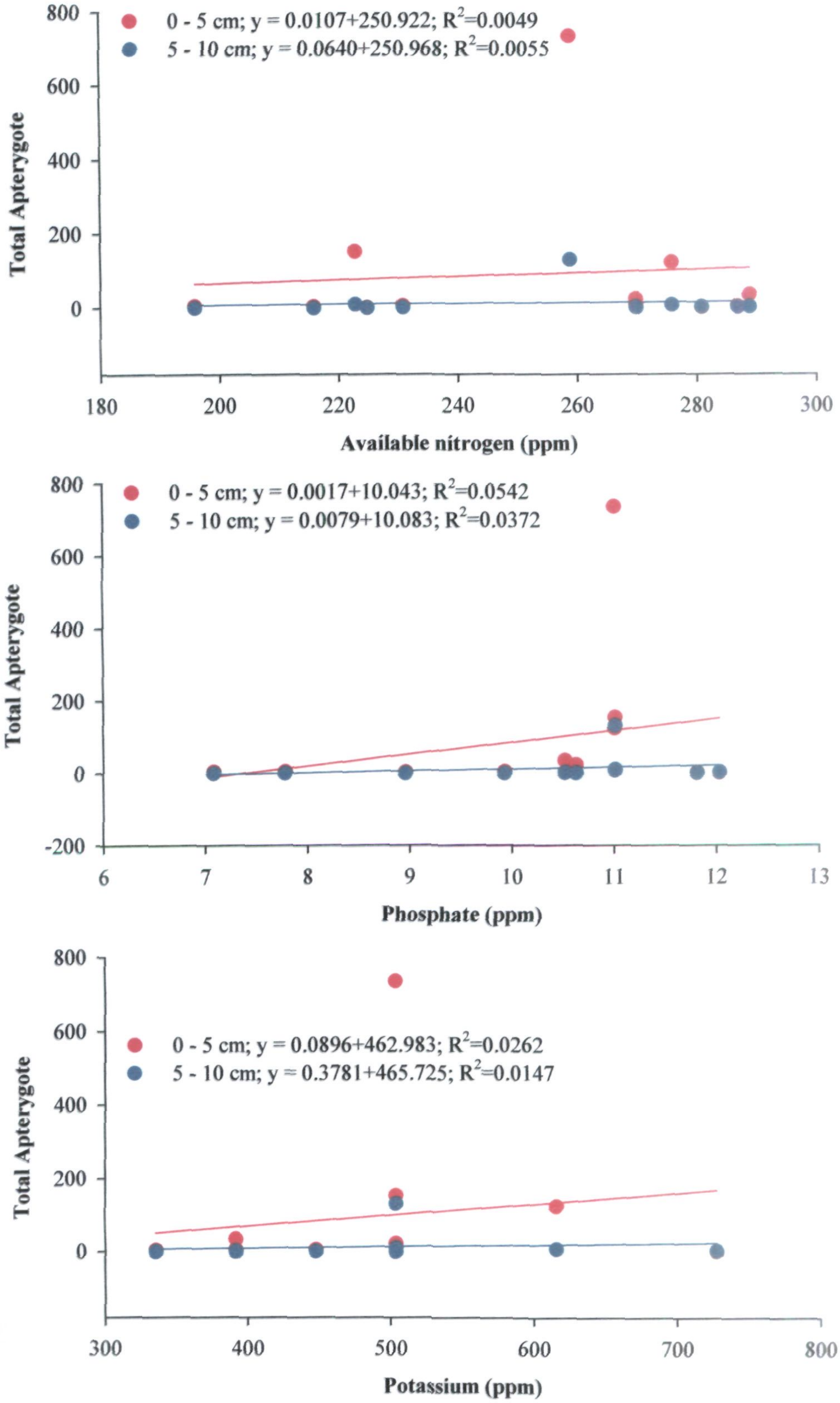


Figure 27f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Unarable Land during 2008-09

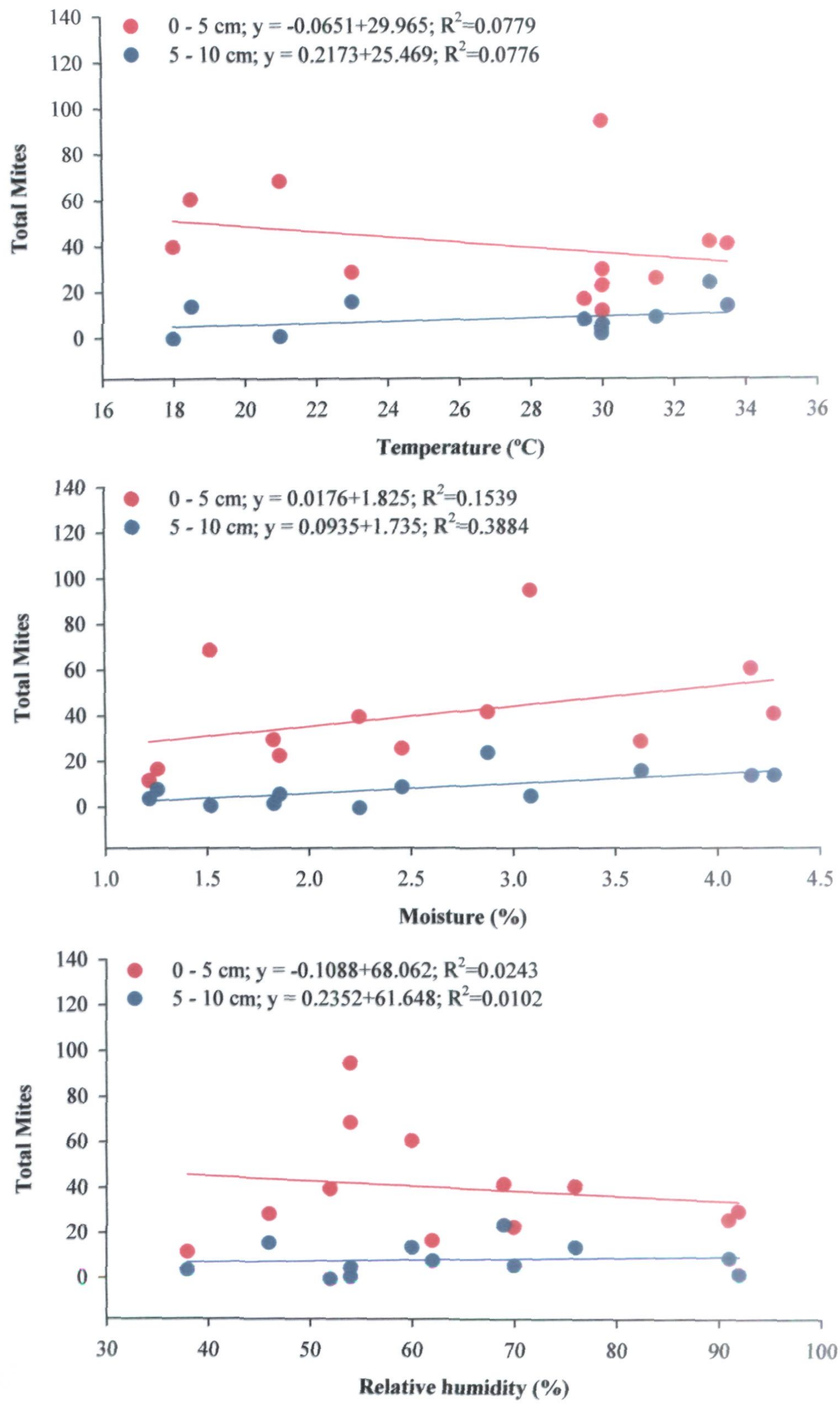


Figure 27g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Unarable Land during 2008-09

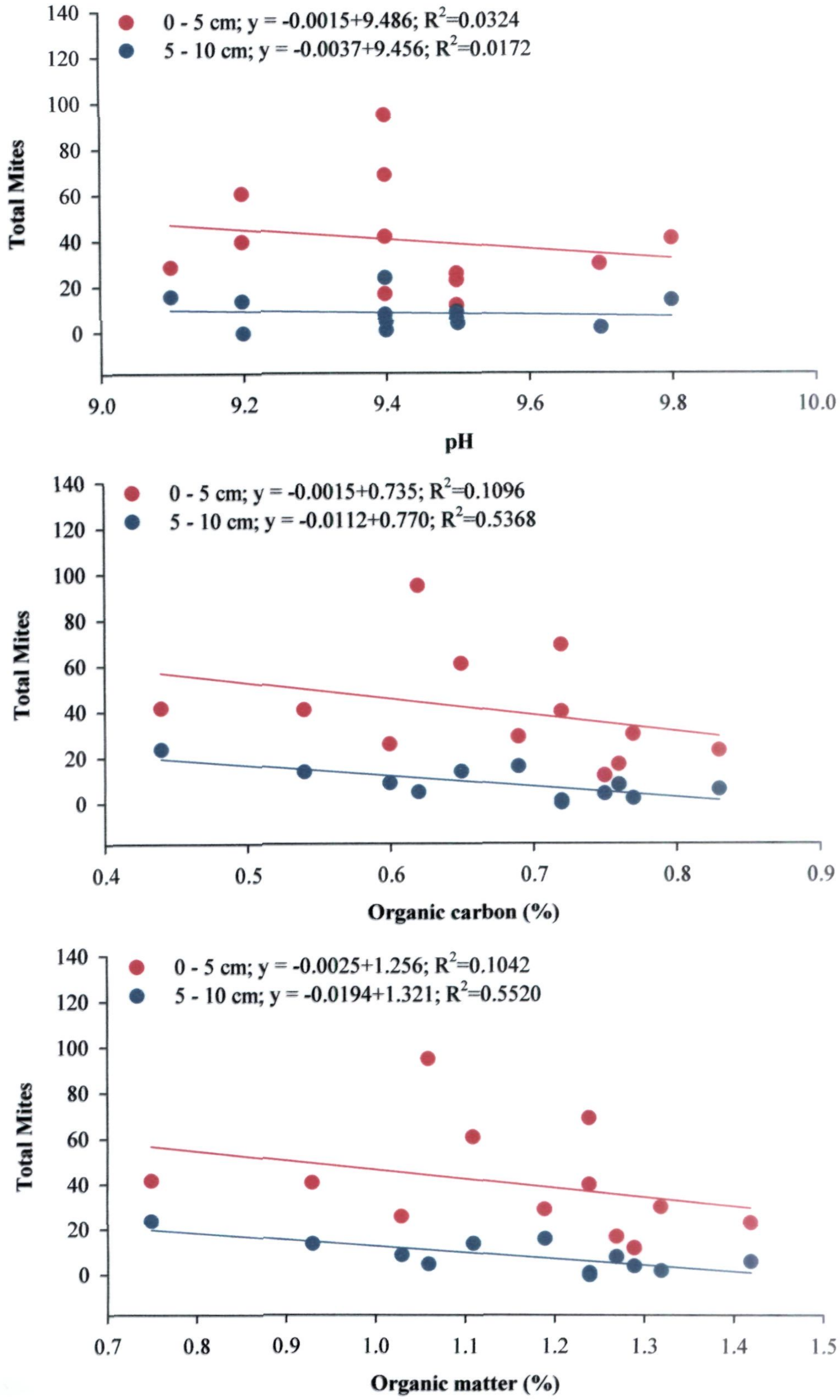


Figure 27h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Unarable Land during 2008-09

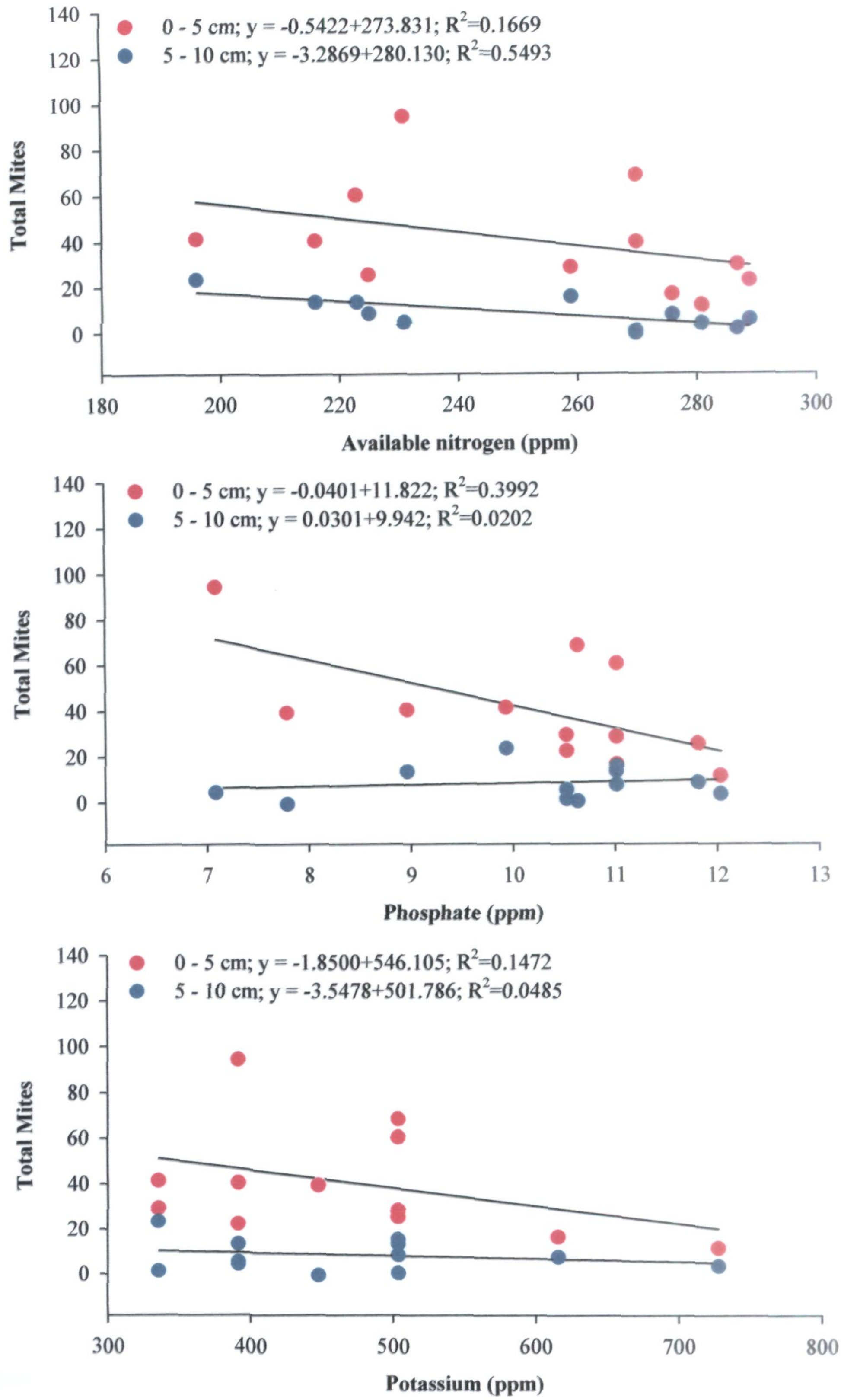


Figure 27i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Unarable Land during 2008-09

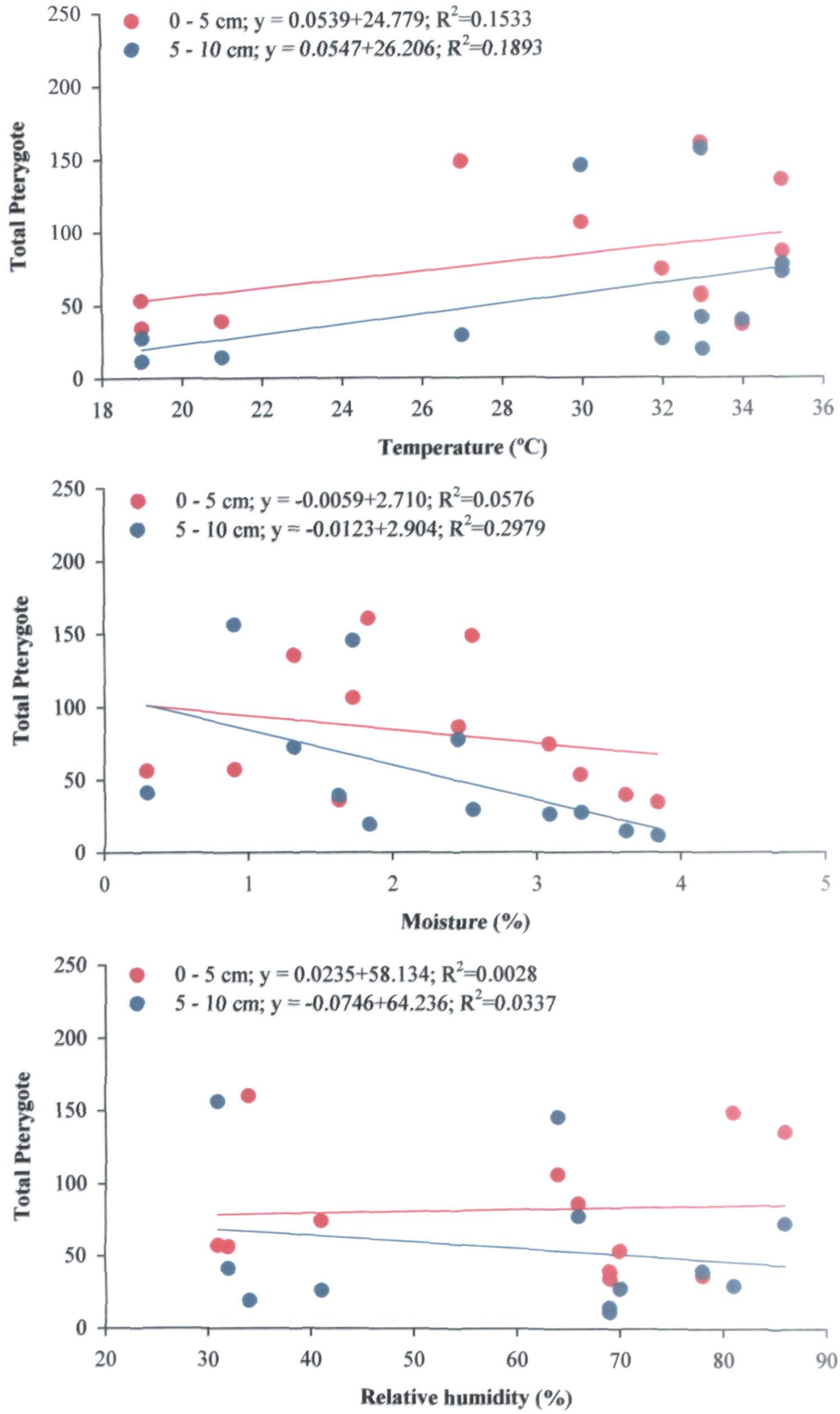


Figure 28a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Unarable Land during 2009-10

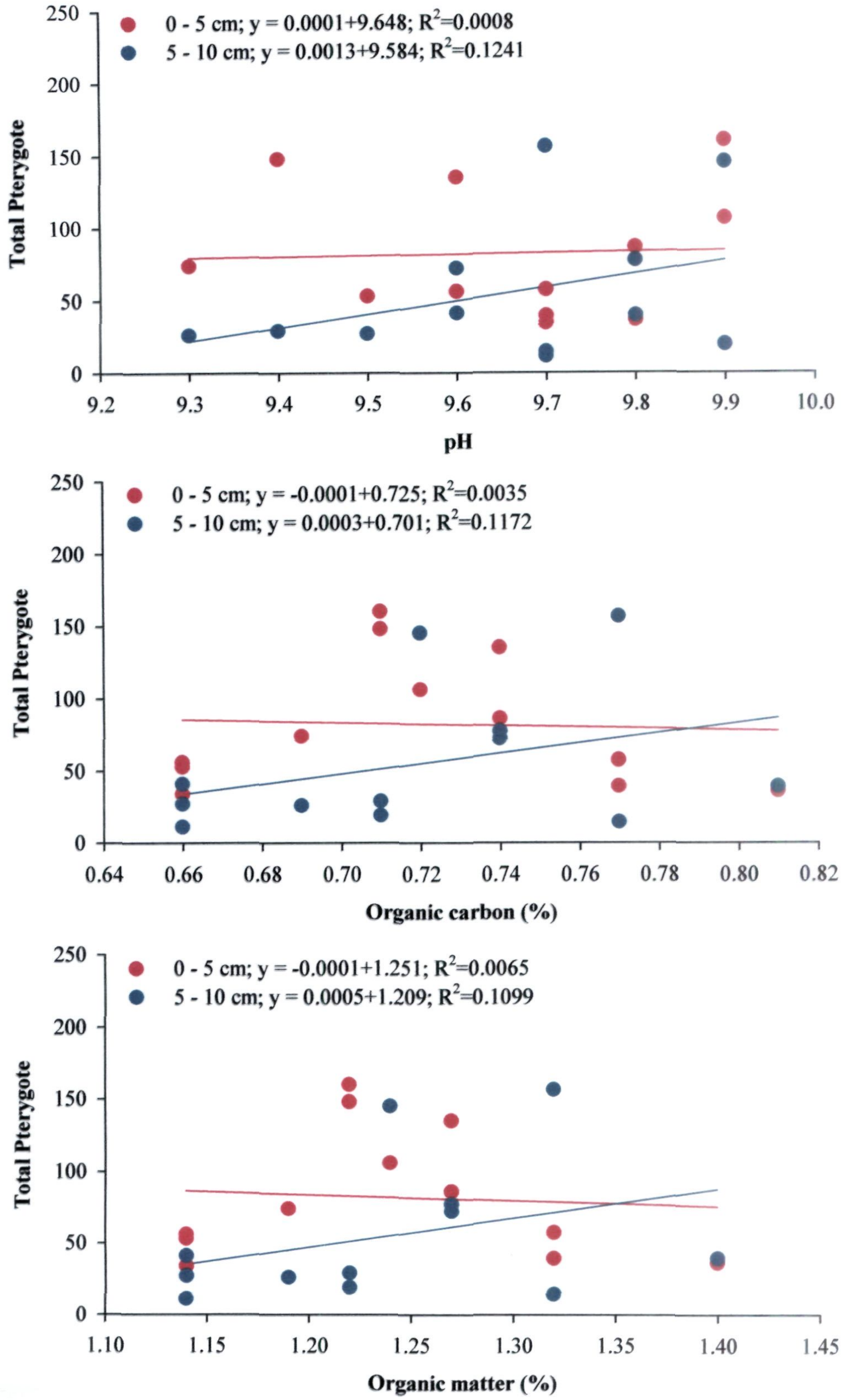


Figure 28b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Unarable Land during 2009-10

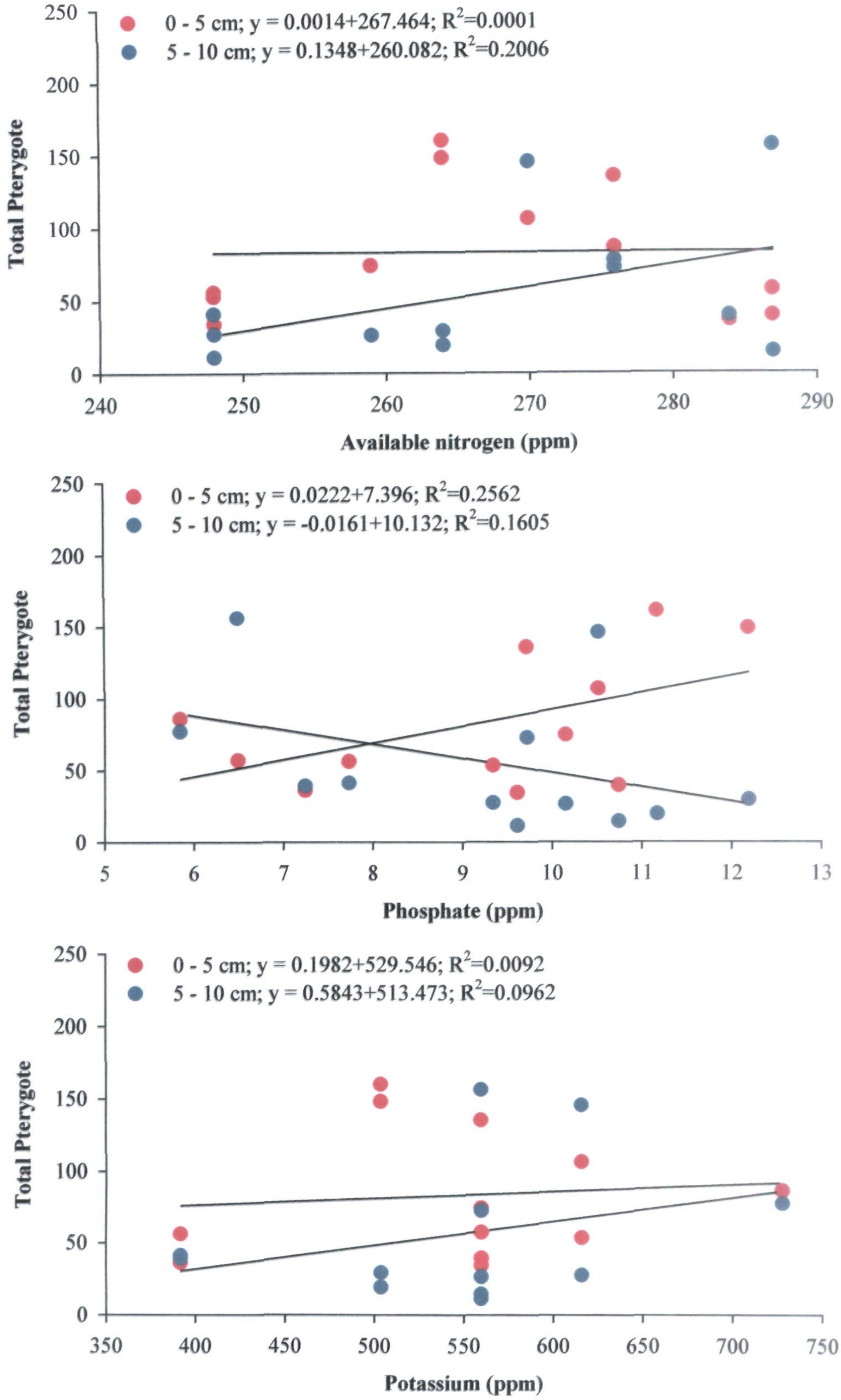


Figure 28c: Regression analysis of total population of pterygote with available nitrogen, phosphate and potassium from the site of Unarable Land during 2009-10

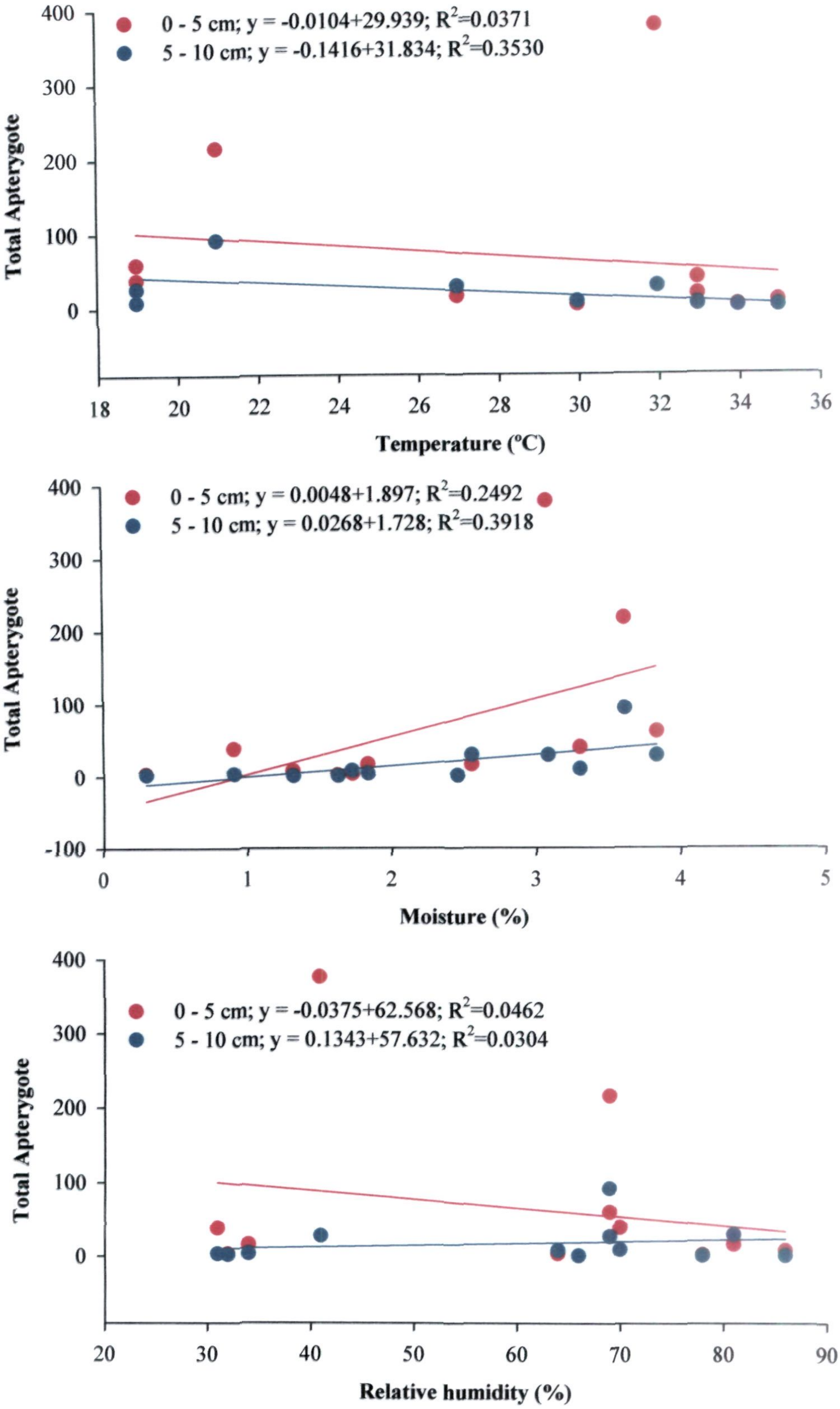


Figure 28d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Unarable Land during 2009-10

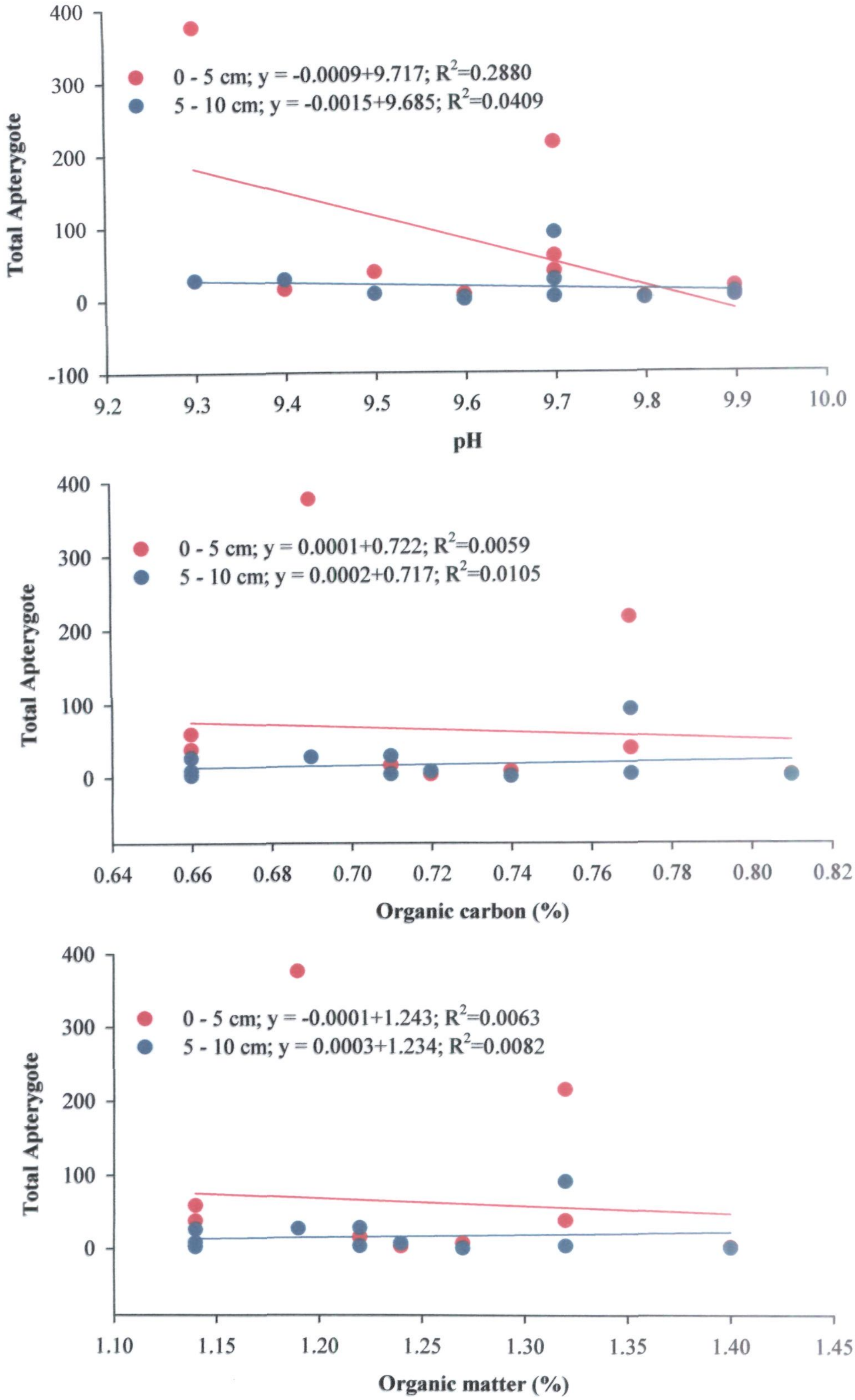


Figure 28e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Unarable Land during 2009-10

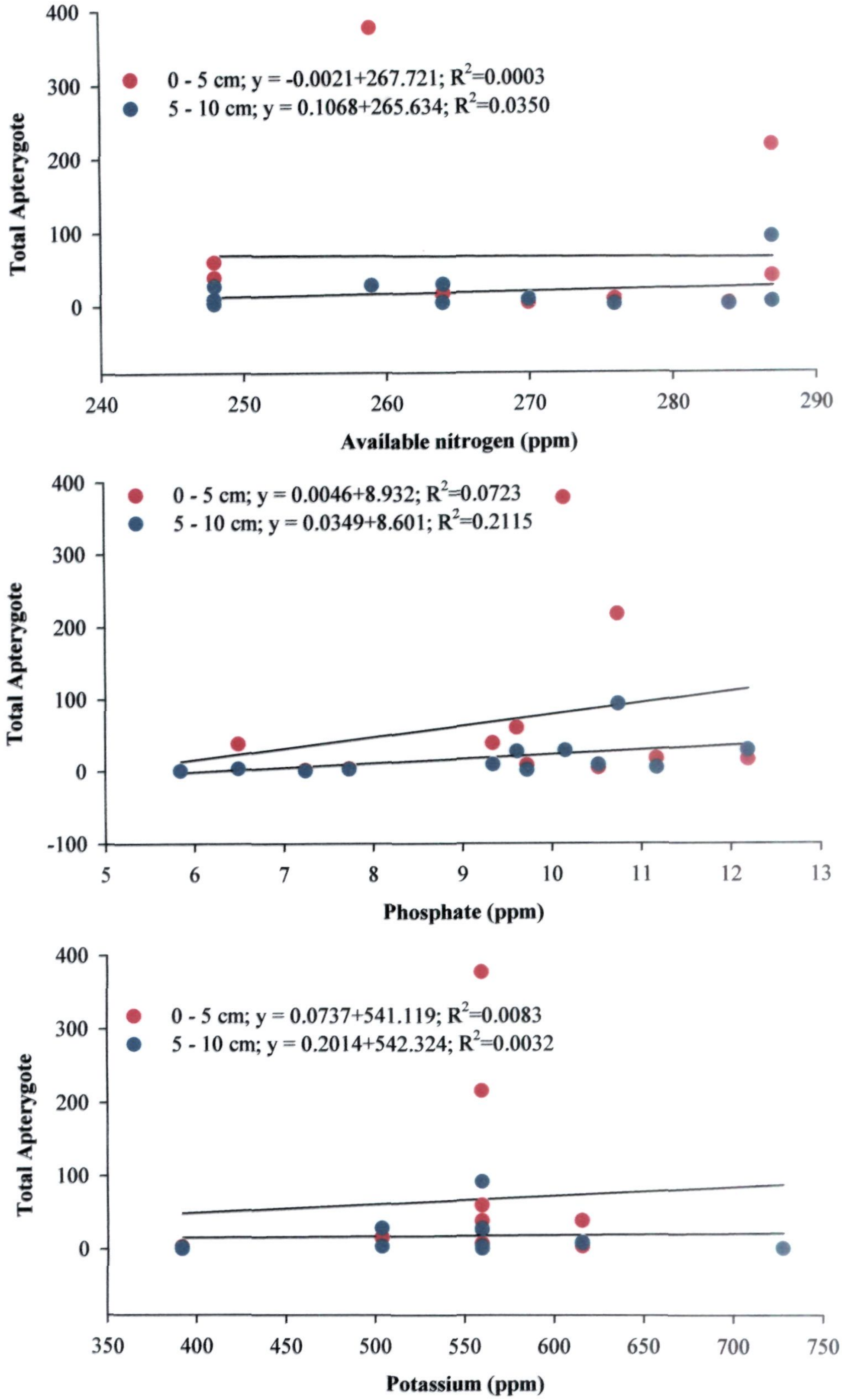


Figure 28f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Unarable Land during 2009-10

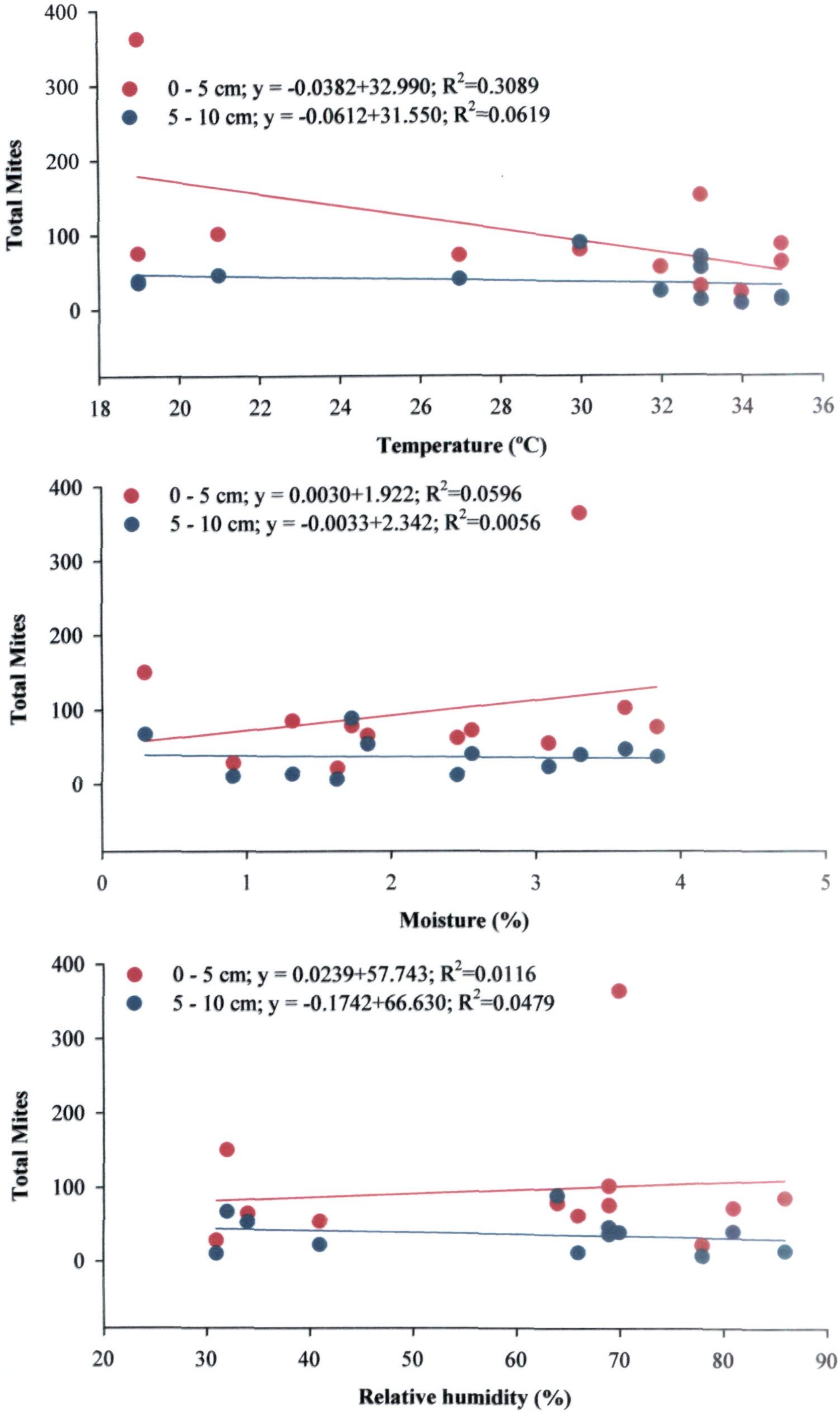


Figure 28g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Unarable Land during 2009-10

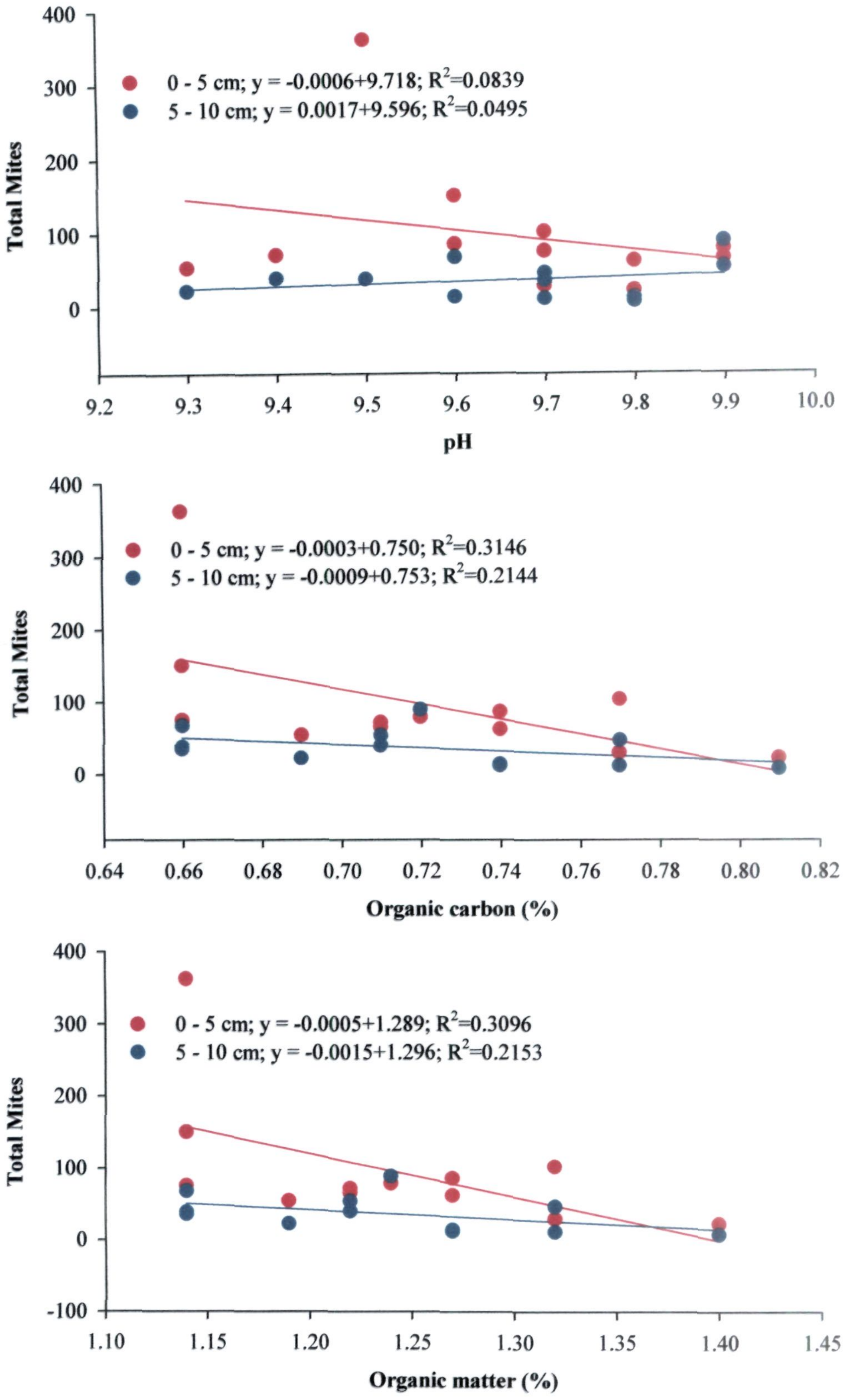


Figure 28h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Unarable Land during 2009-10

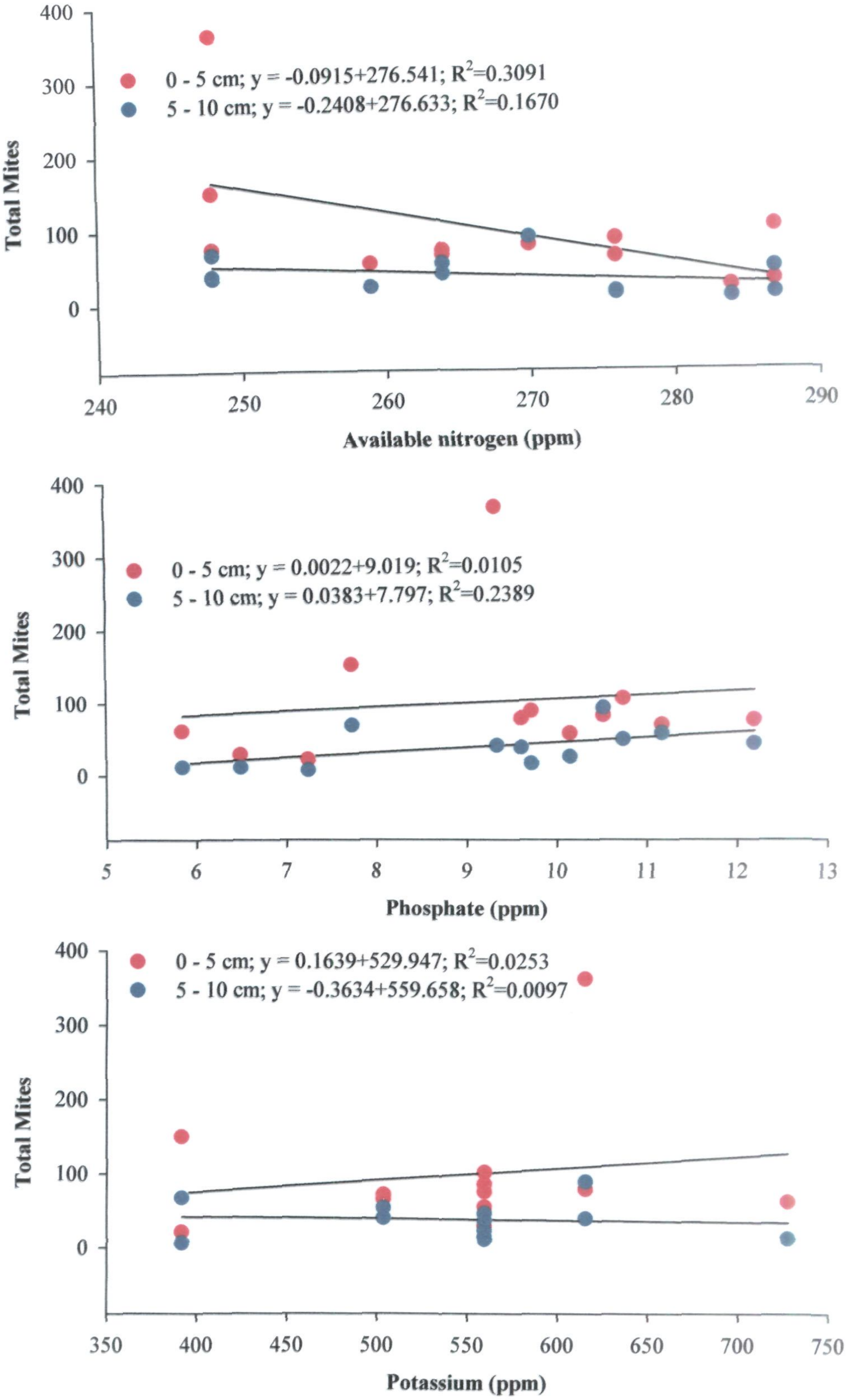


Figure 28i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Unarable Land during 2009-10

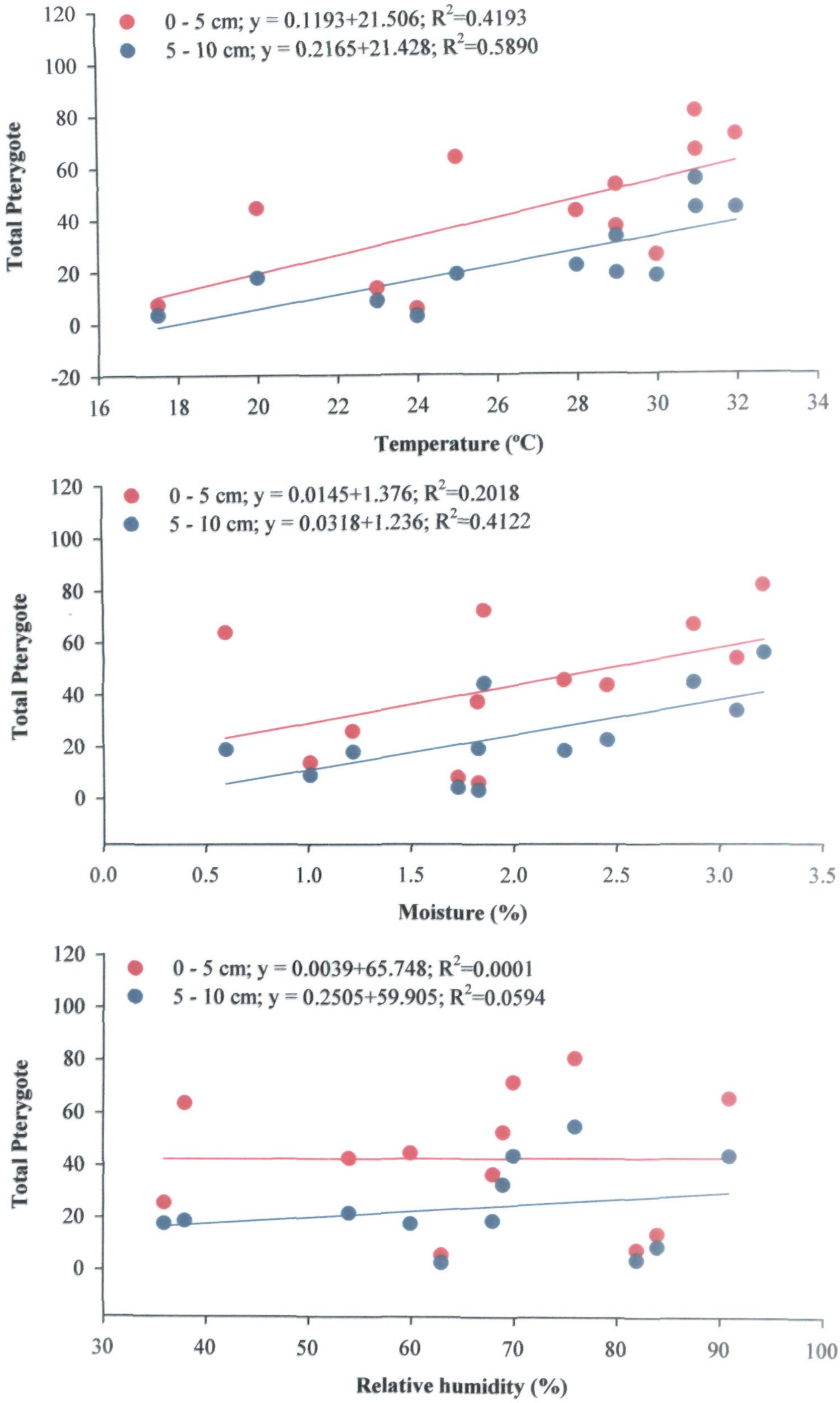


Figure 29a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Wheat Field during 2008-09

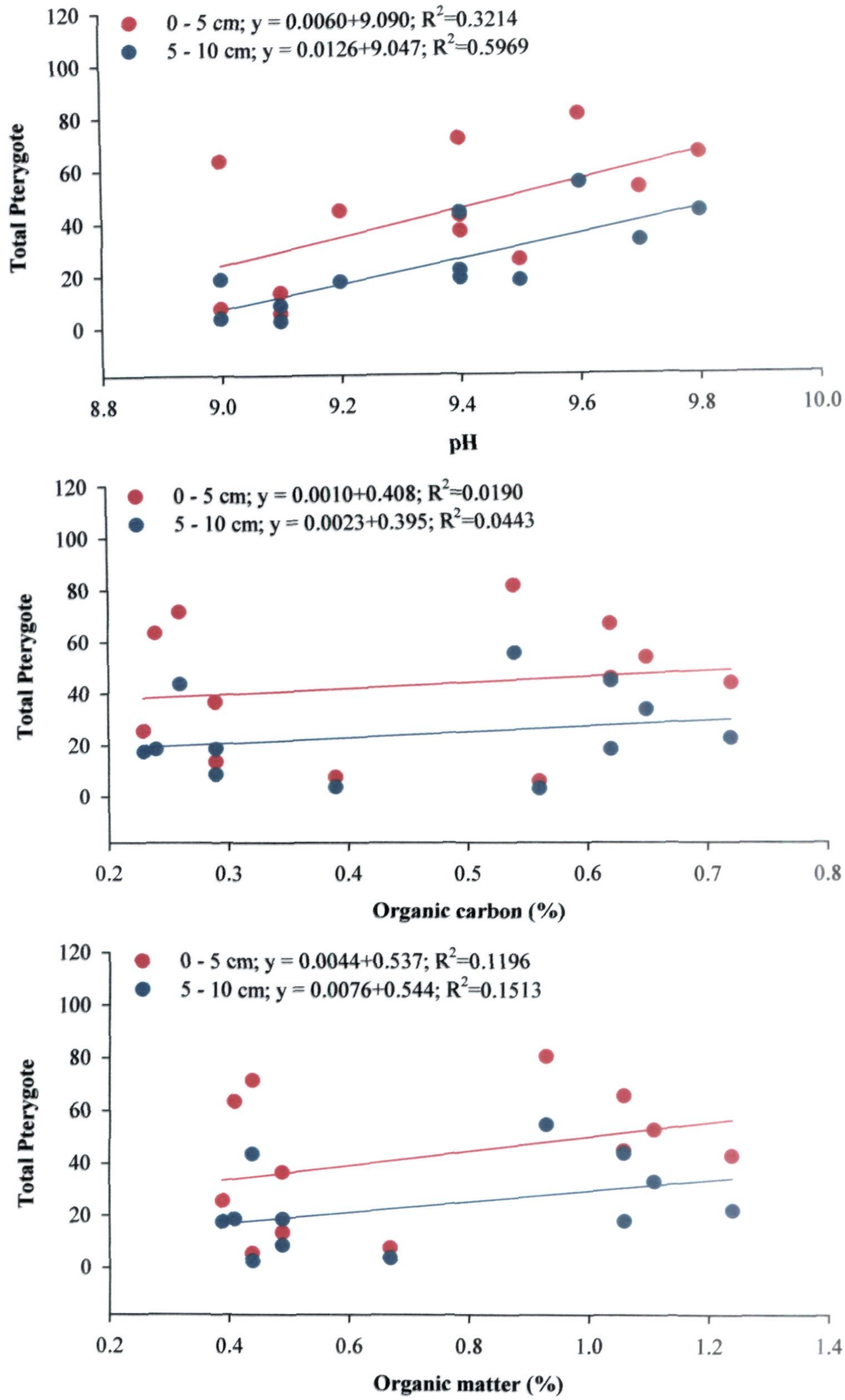


Figure 29b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Wheat Field during 2008-09

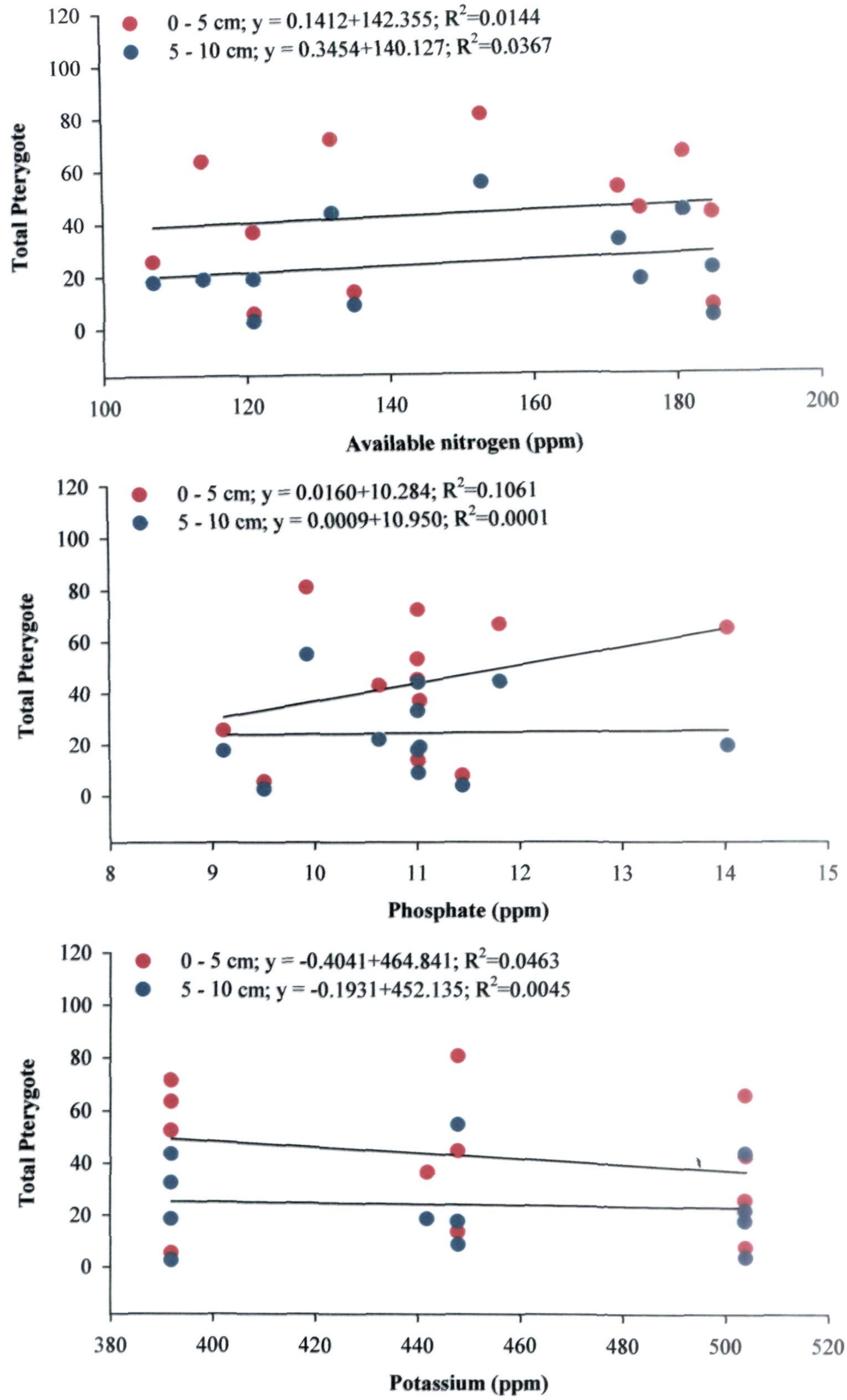


Figure 29c: Regression analysis of total population of pterygote with available nitrogen, phosphate and potassium from the site of Wheat Field during 2008-09

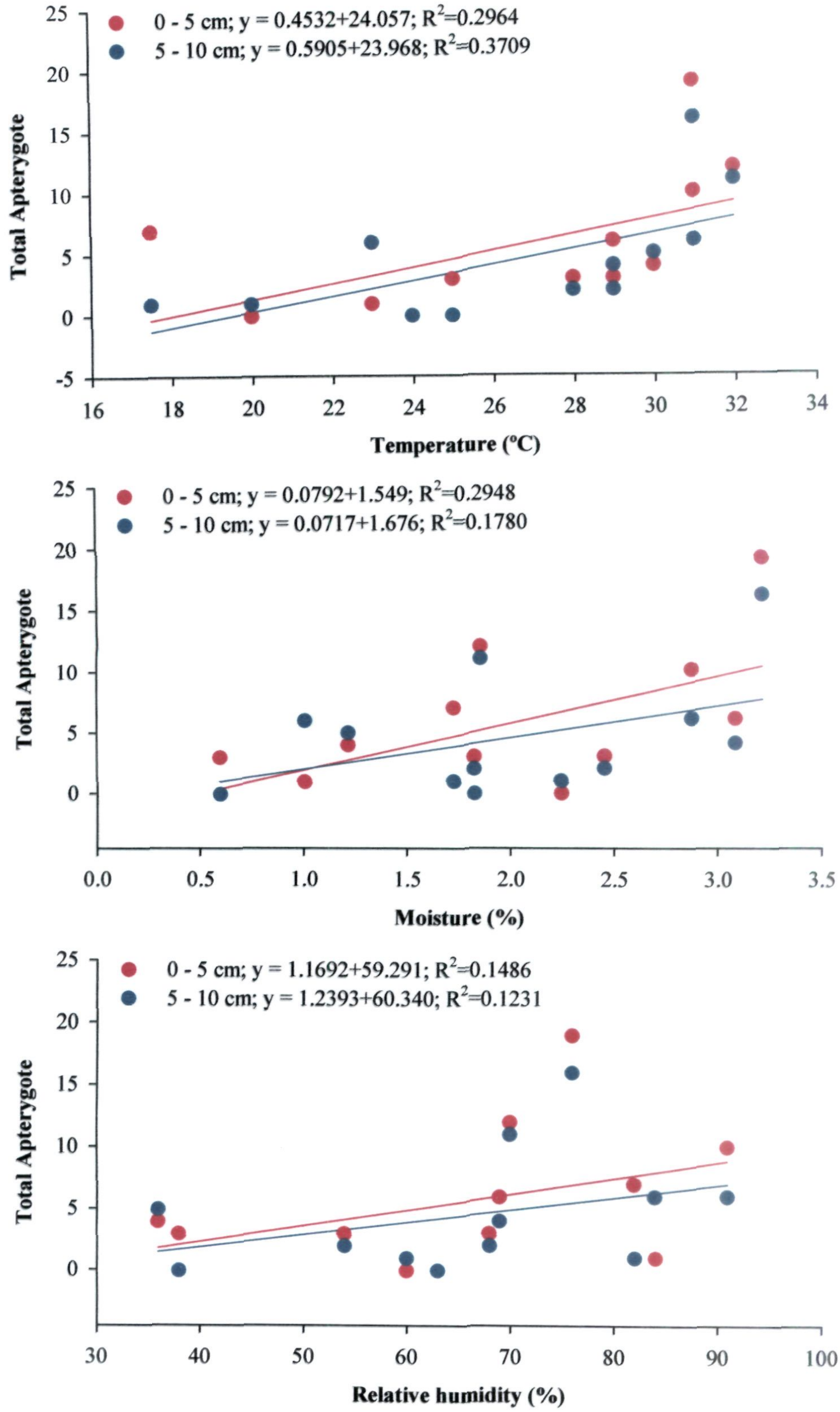


Figure 29d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Wheat Field during 2008-09

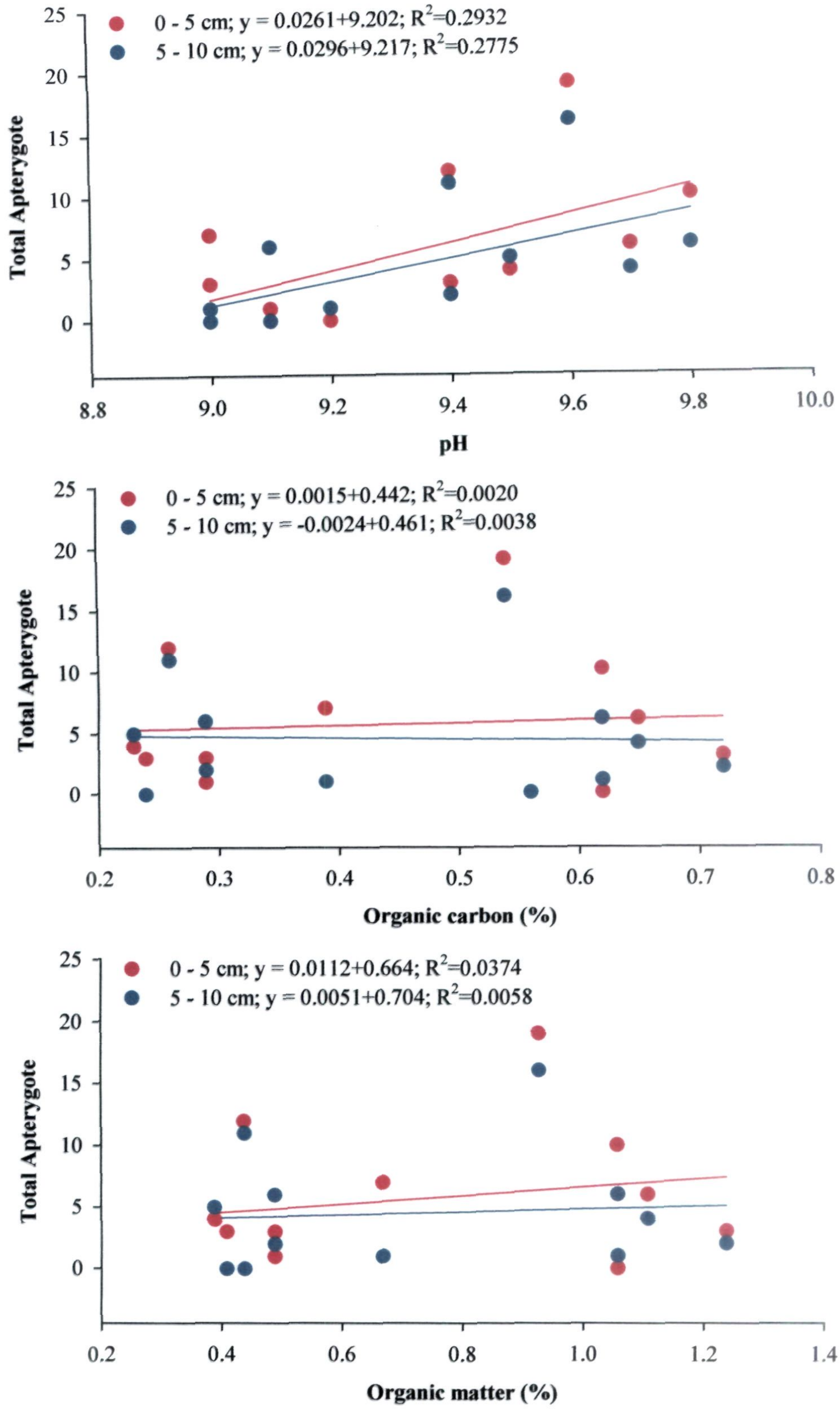


Figure 29e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Wheat Field during 2008-09

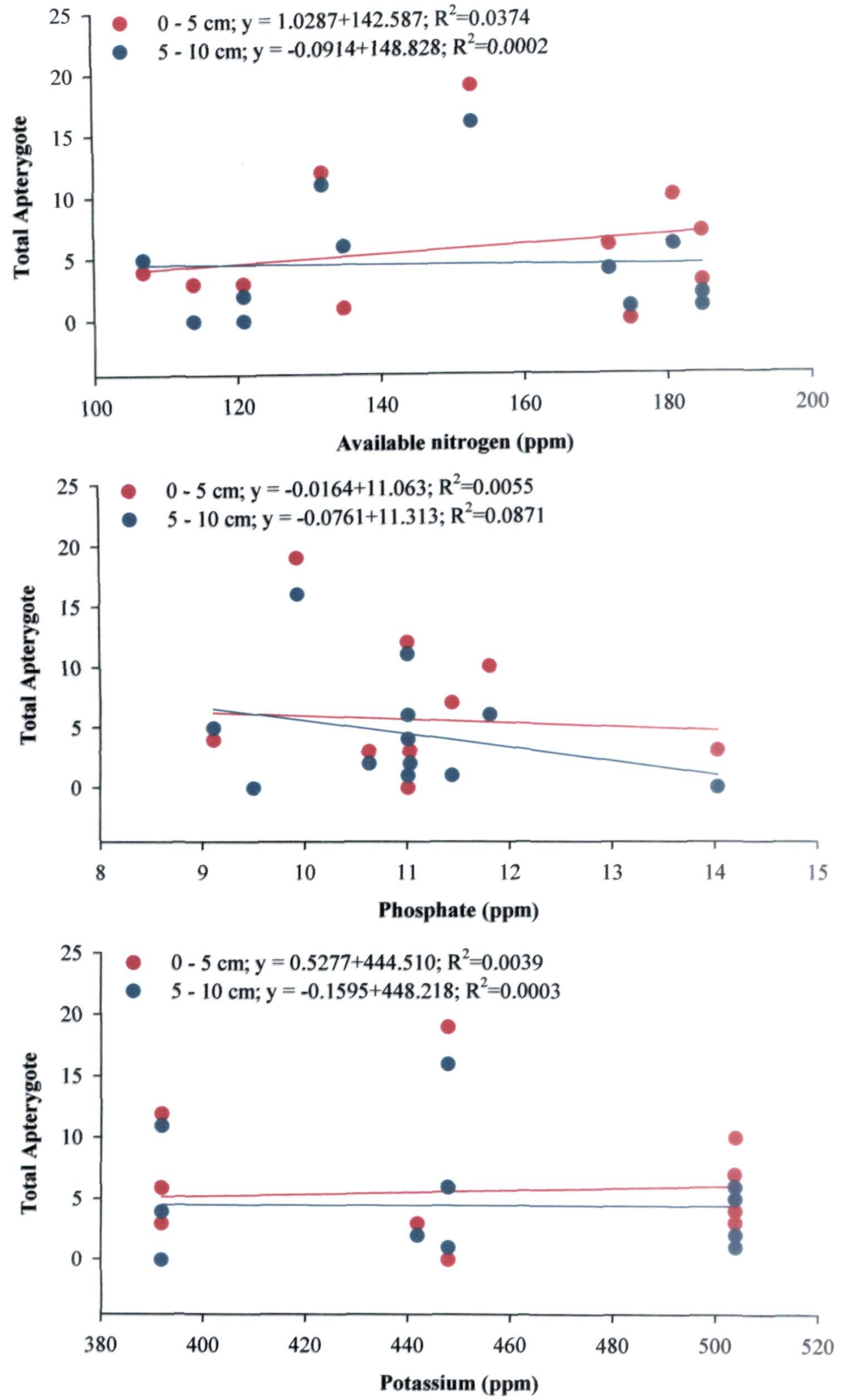


Figure 29f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Wheat Field during 2008-09

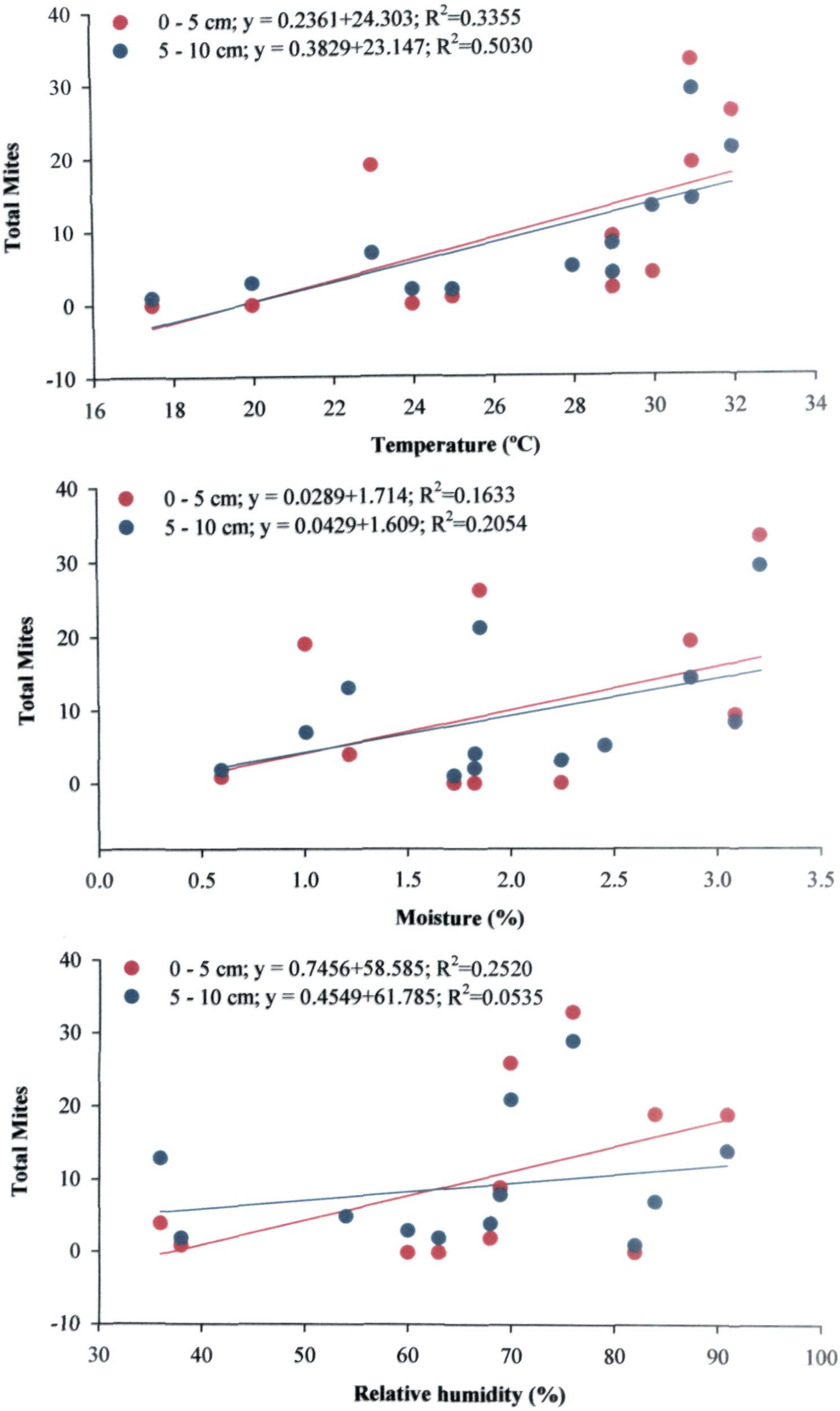


Figure 29g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Wheat Field during 2008-09

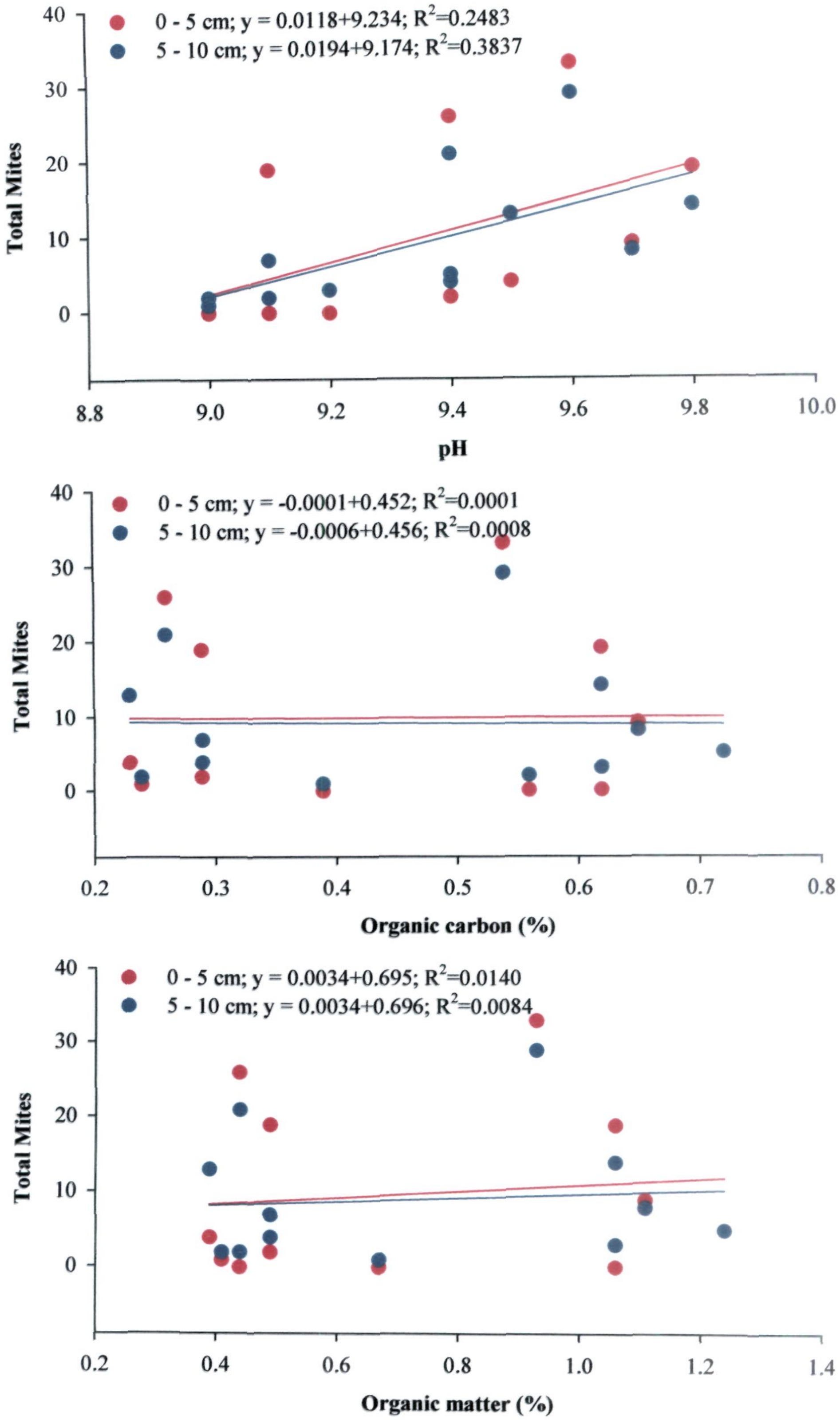


Figure 29h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Wheat Field during 2008-09

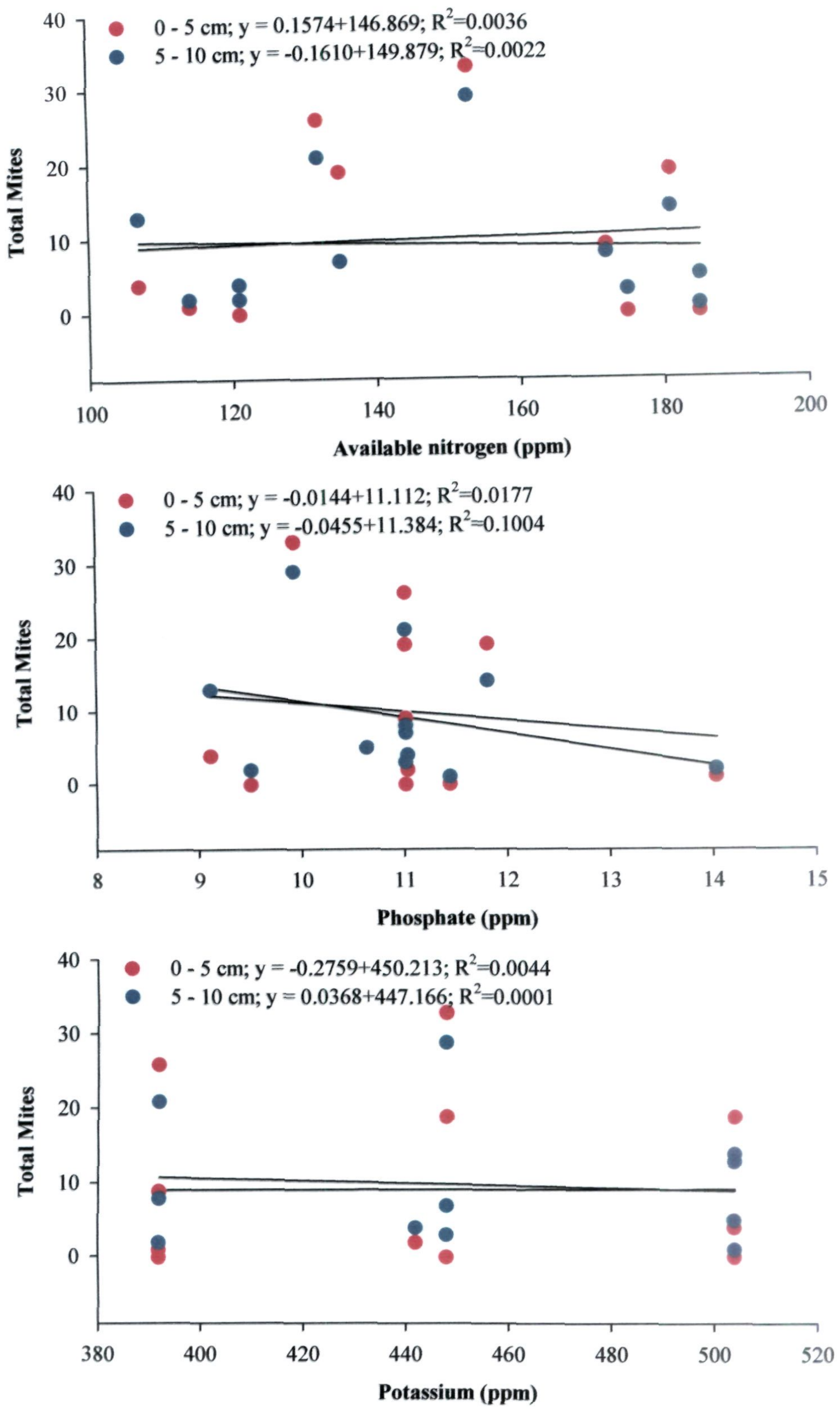


Figure 29i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Wheat Field during 2008-09

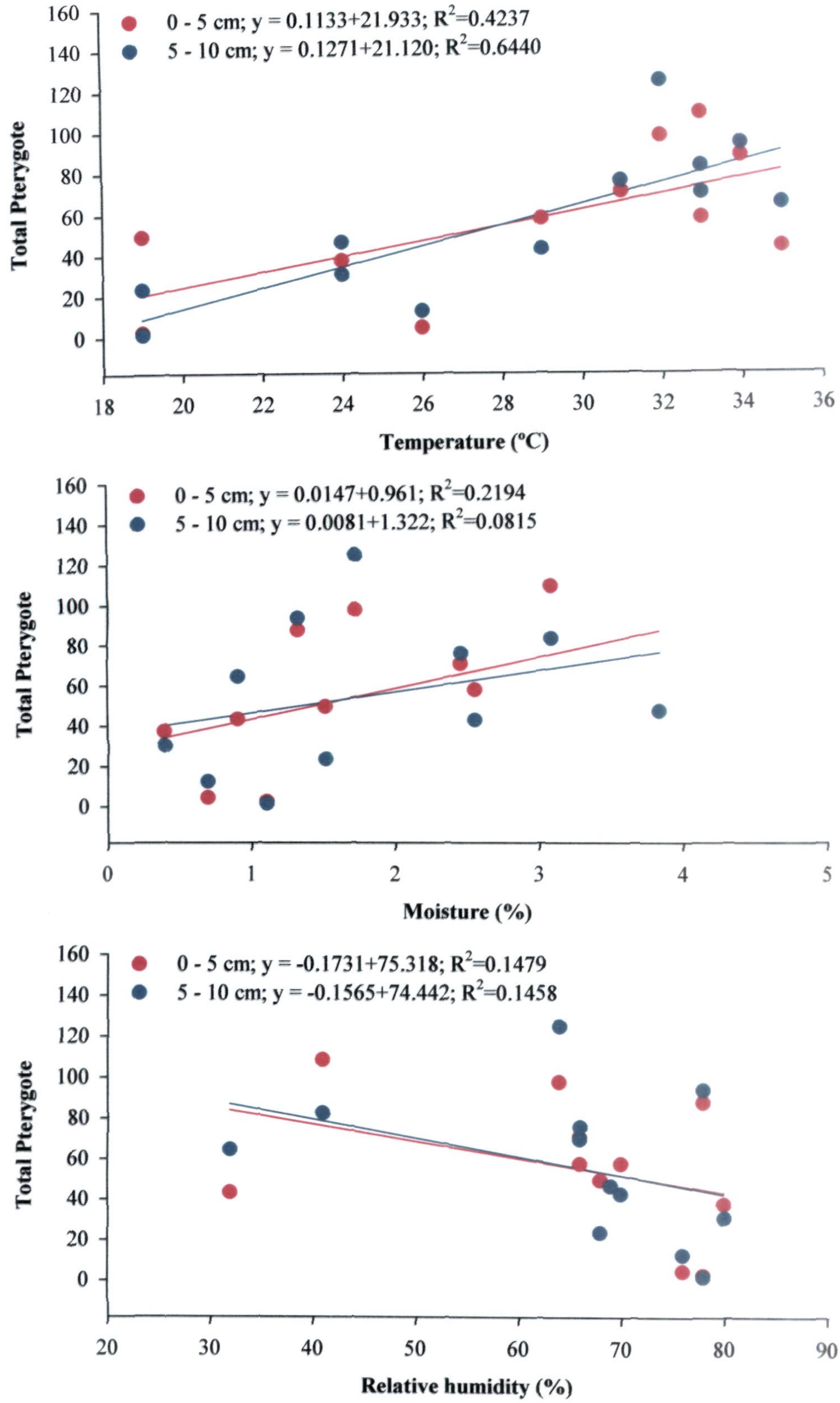


Figure 30a: Regression analysis of total population of pterygote with Temperature, Moisture and Relative Humidity from the site of Wheat Field during 2009-10

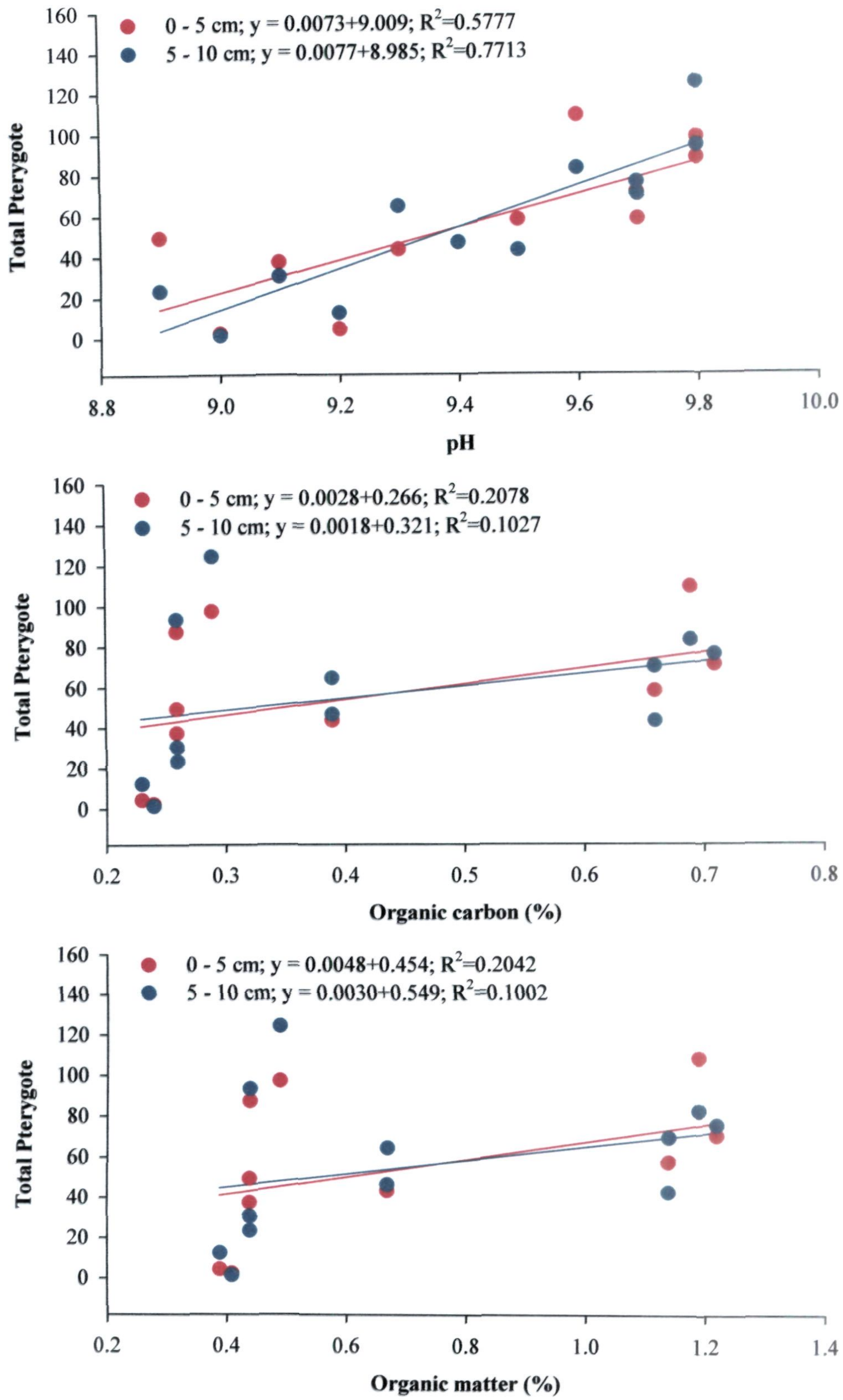


Figure 30b: Regression analysis of total population of pterygote with pH, organic carbon and organic matter from the site of Wheat Crop during 2009-10

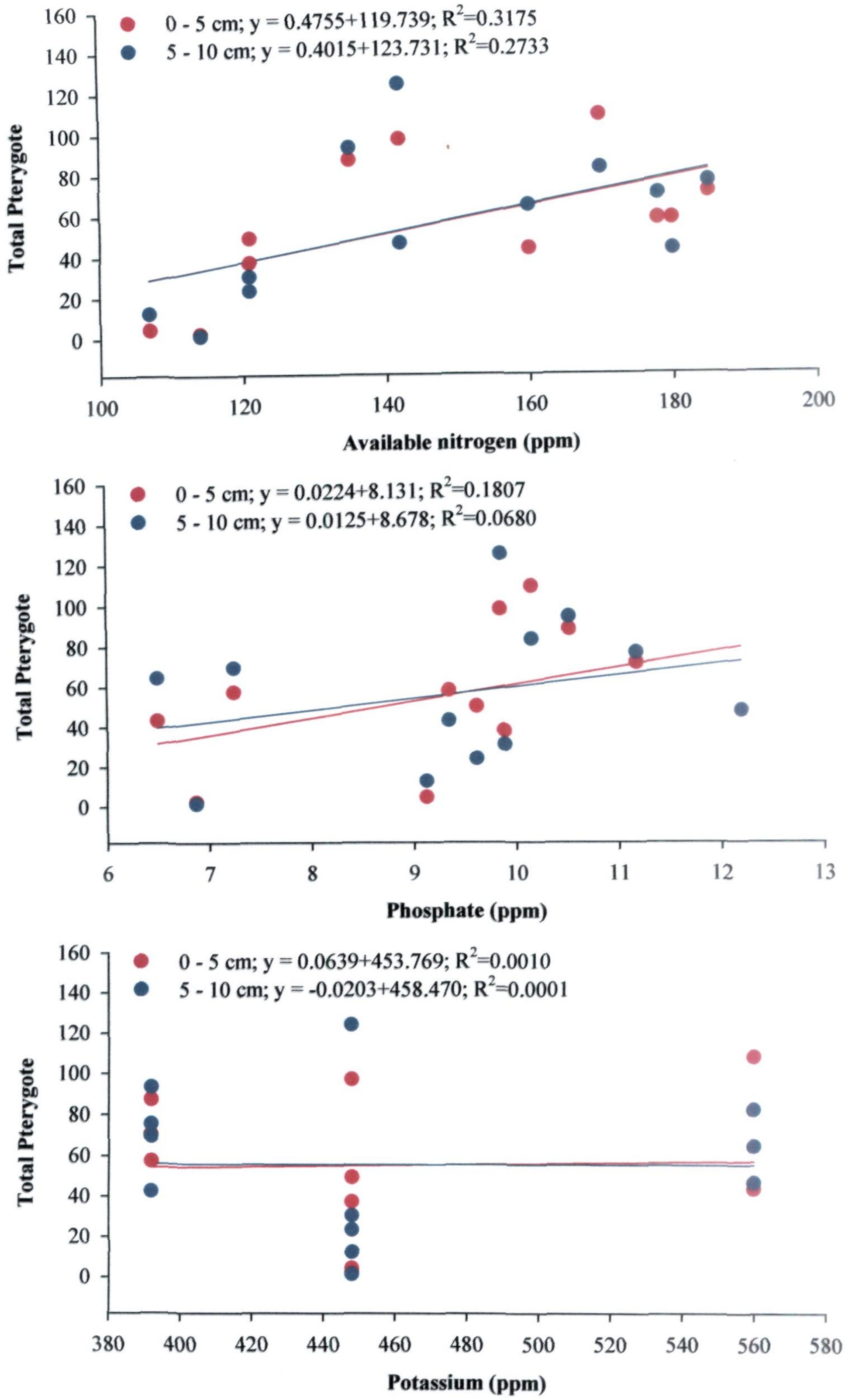


Figure 30c: Regression analysis of total population of pterygote with available nitrogen, phosphate and potassium from the site of Wheat Field during 2009-10

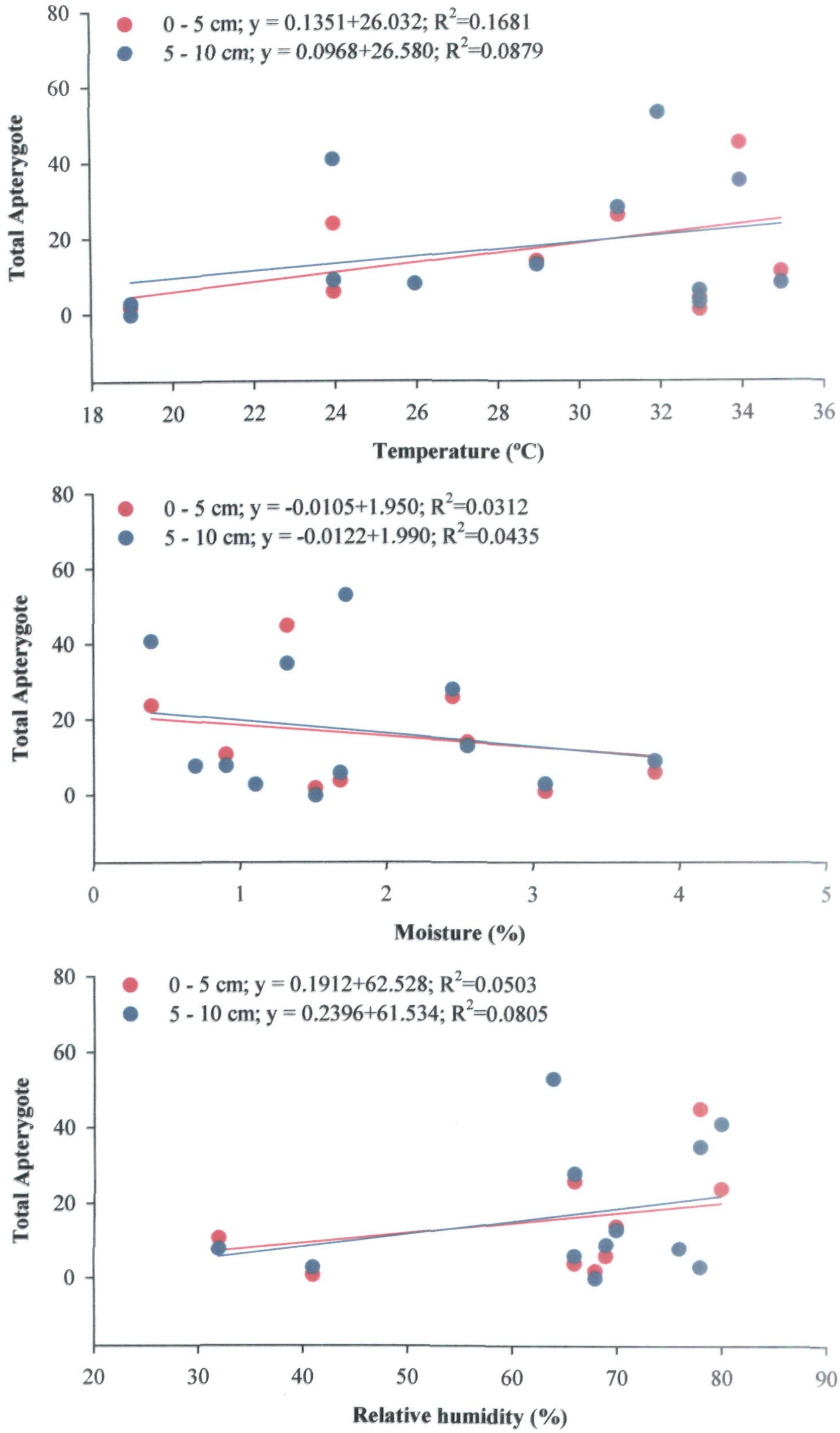


Figure 30d: Regression analysis of total population of apterygote with Temperature, Moisture and Relative Humidity from the site of Wheat Field during 2009-10

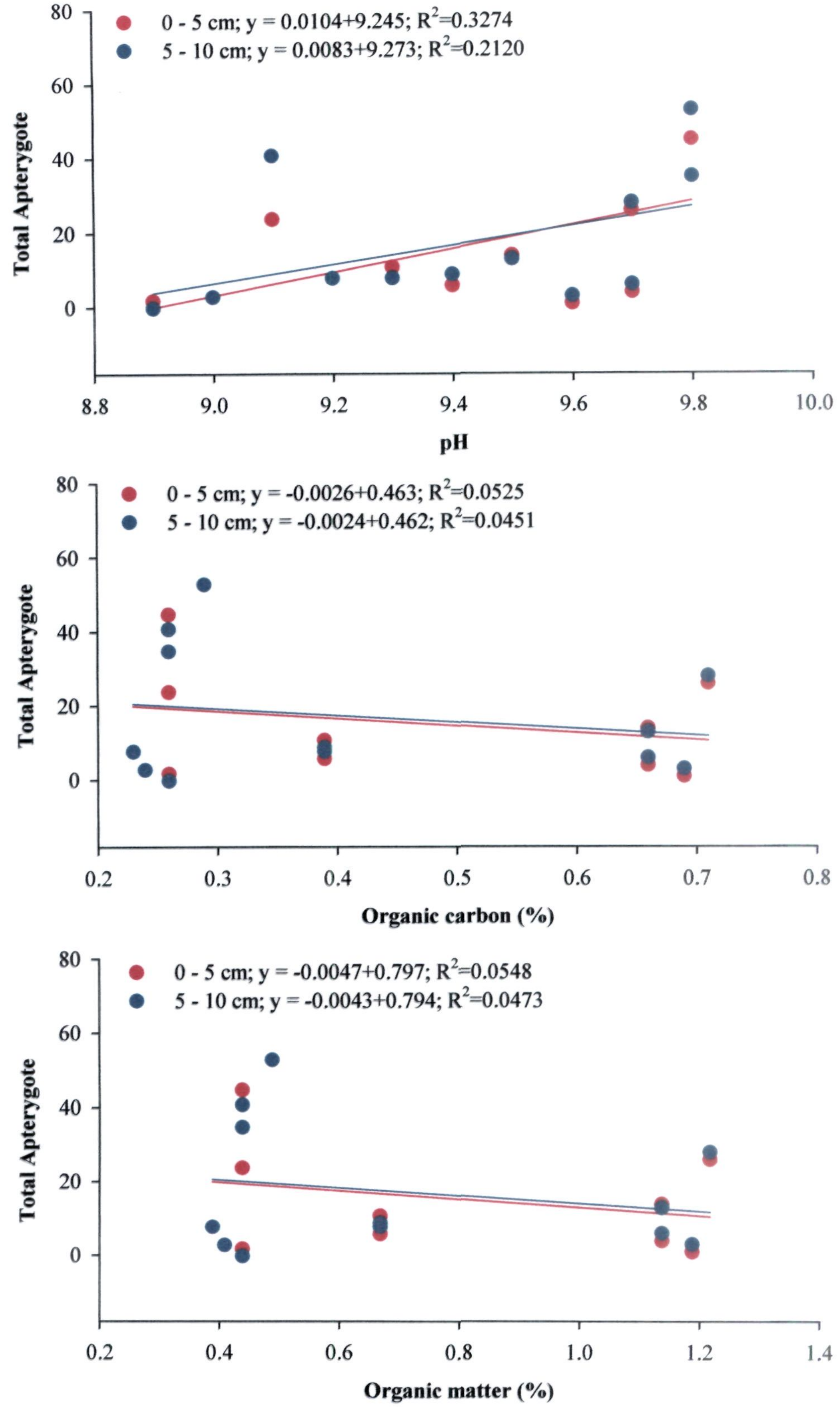


Figure 30e: Regression analysis of total population of apterygote with pH, organic carbon and organic matter from the site of Wheat Field during 2009-10

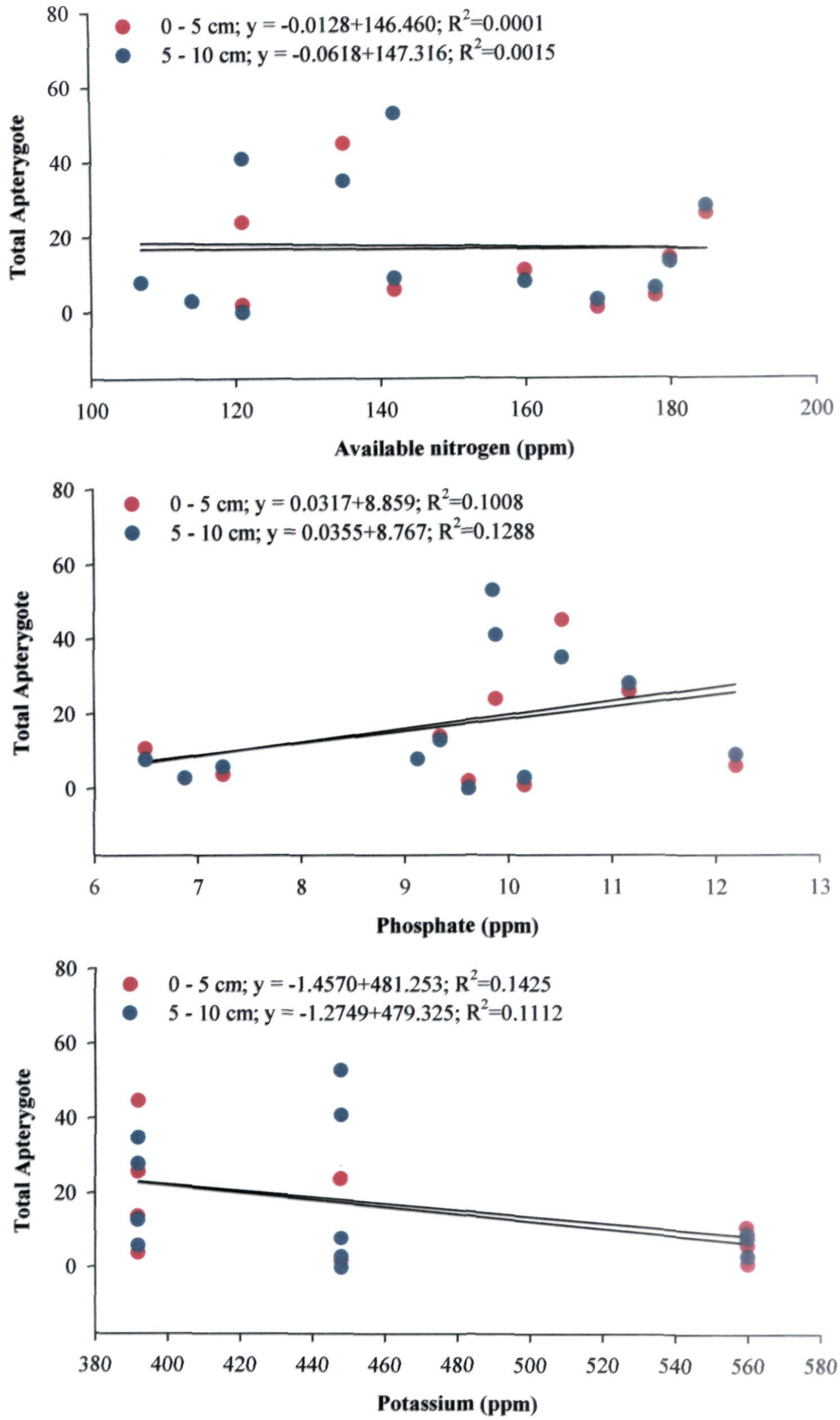


Figure 30f: Regression analysis of total population of apterygote with available nitrogen, phosphate and potassium from the site of Wheat Crop during 2009-10

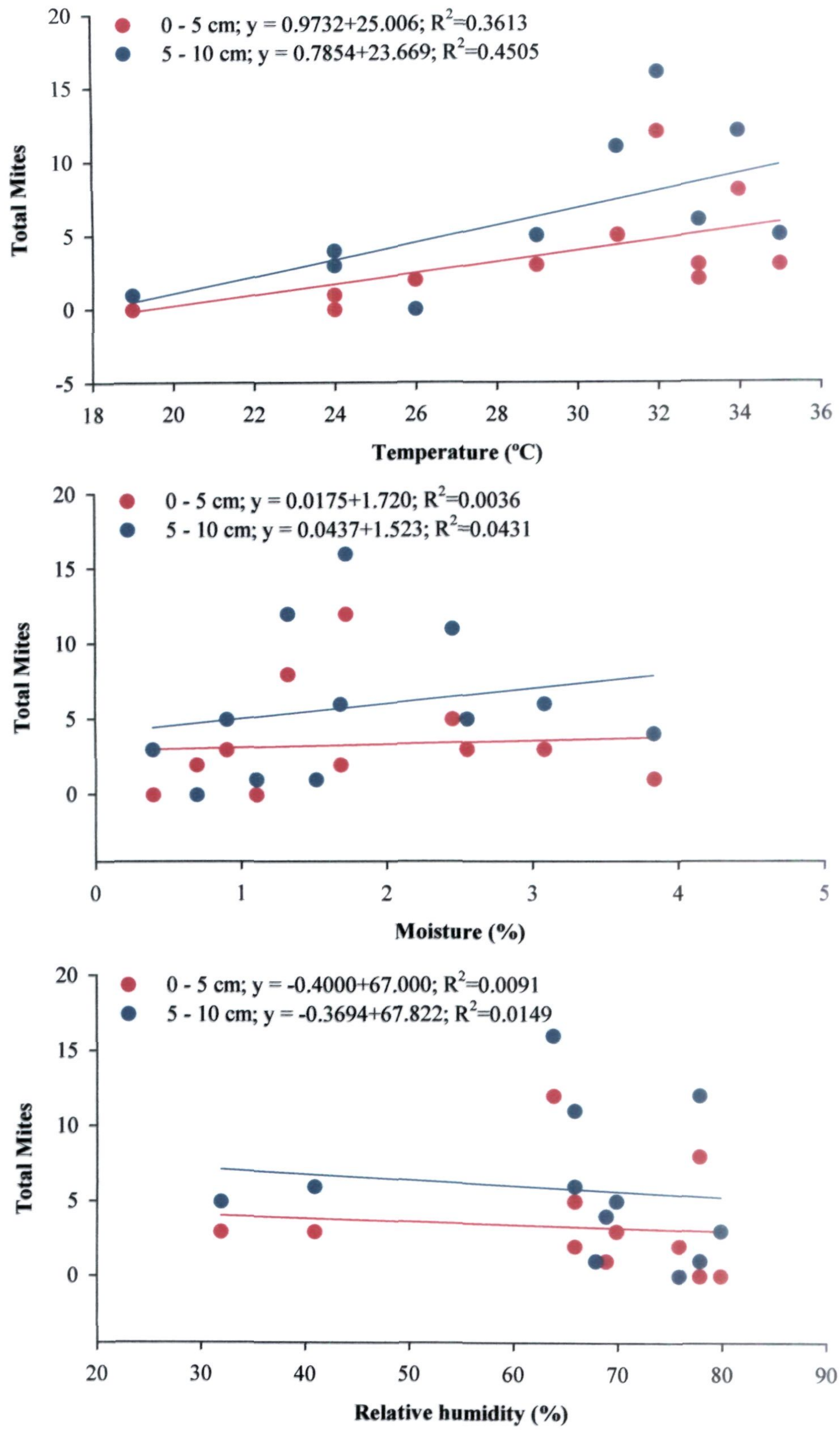


Figure 30g: Regression analysis of total population of mites with Temperature, Moisture and Relative Humidity from the site of Wheat Field during 2009-10

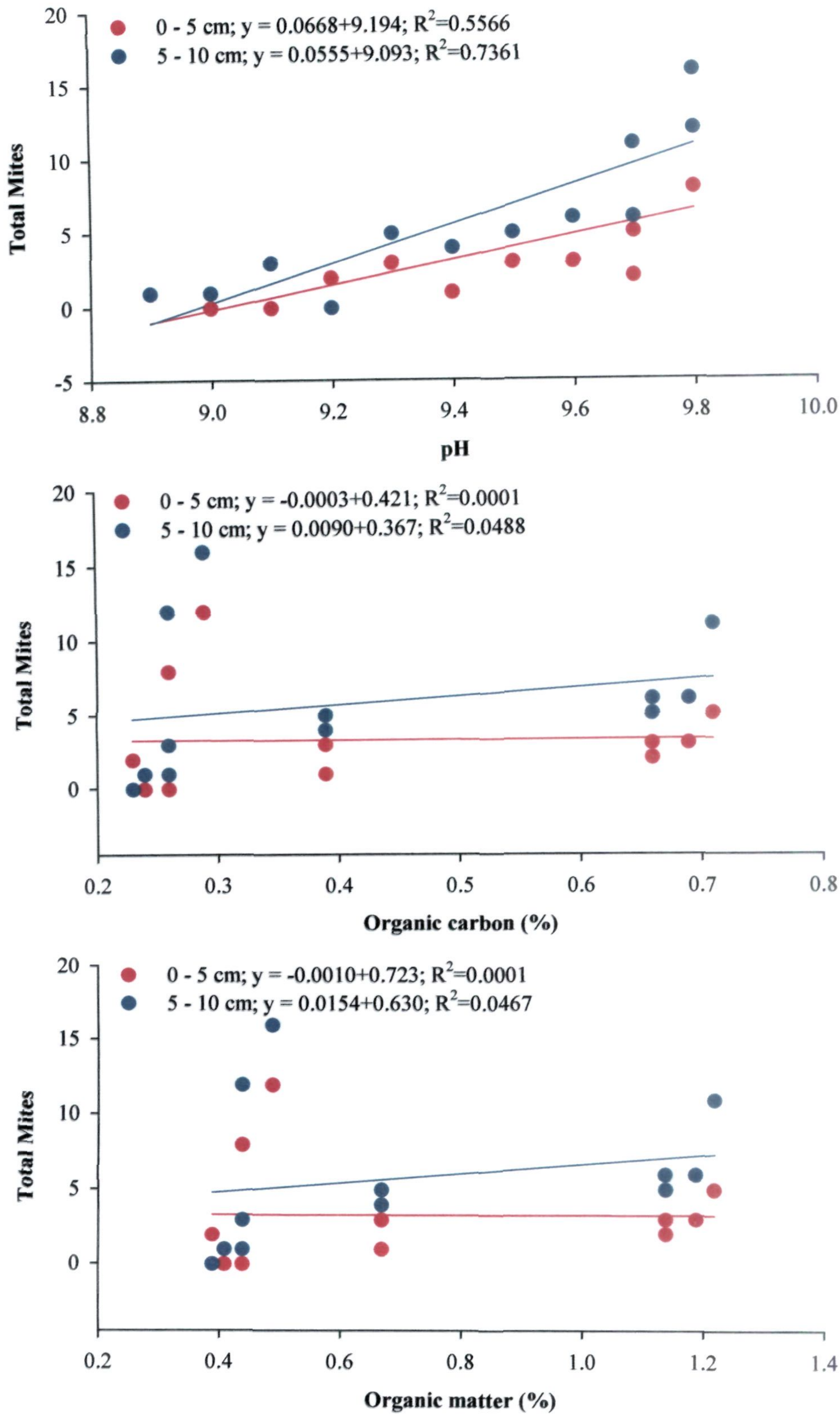


Figure 30h: Regression analysis of total population of mites with pH, organic carbon and organic matter from the site of Wheat Field during 2009-10

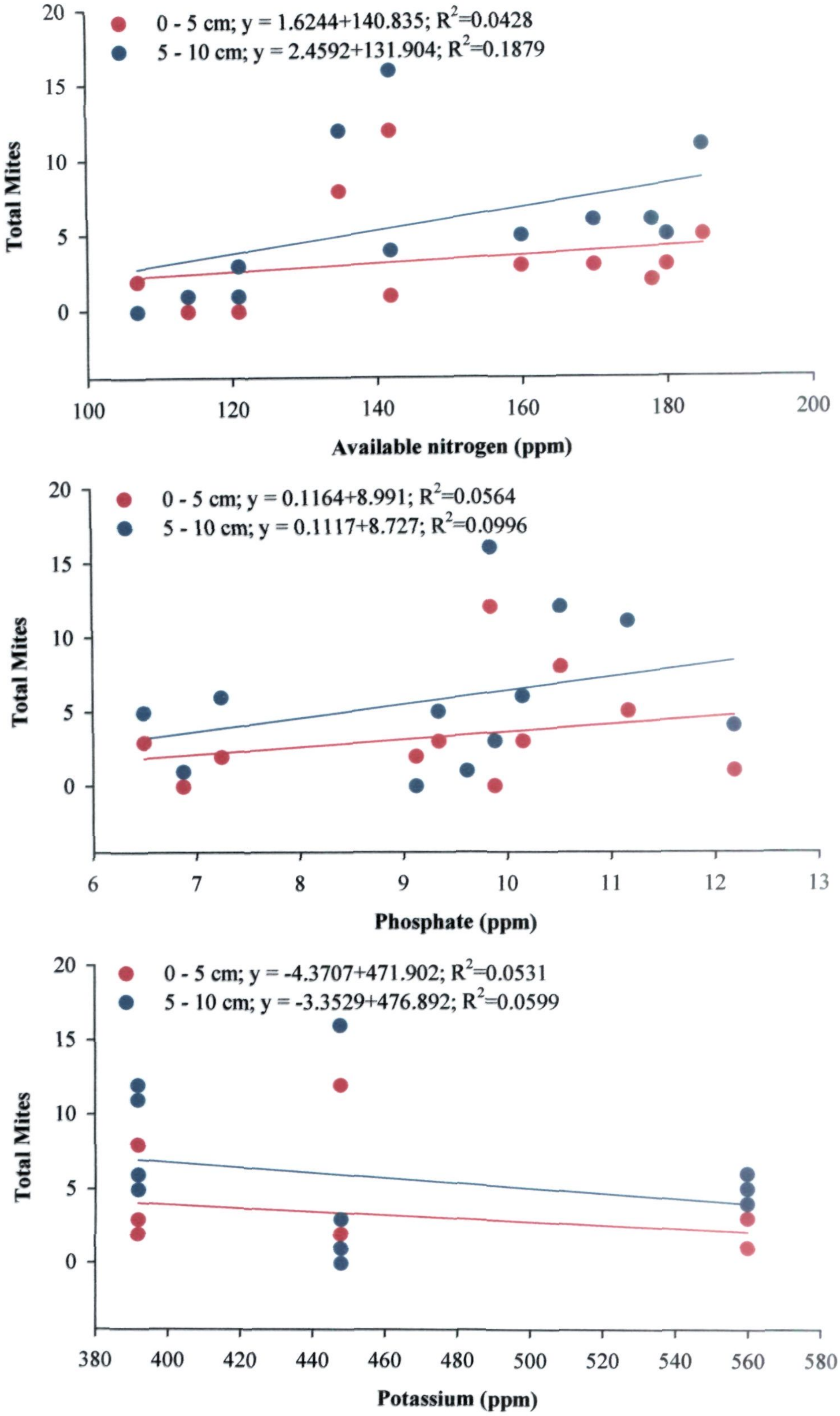


Figure 30i: Regression analysis of total population of mites with available nitrogen, phosphate and potassium from the site of Wheat Field during 2009-10

Discussion

DISCUSSION

The results presented in this investigation were based on the survey of samples from four sites located within a radius of 5 Km in and around Aligarh Muslim University Campus. A total of 344 samples were collected at the rate of four samples in a month from the foresaid areas, consisting of both litter and mineral soil, each over a period of two years (March 2008 – Feb 2010). The sampling sites were diverse in nature as far as their vegetational component was concerned. The soils of Aligarh district are alluvial with little leaching and considerable accumulation of salts on surface. The alluvial beds varying from olive brown to ash gray in colour, very strongly alkaline to weak alkaline in nature, pass through the successive layers of sand, sandy silt and clay with occasional compact beds of an indurated character. The mechanical analysis of the soil revealed that the nature of the soil in all the sites were more as less identical.

POPULATION FLUCTUATION OF INSECTS AND MITES

Litter population

The teak plantation area remains shaded throughout the year: the leaves of the teak *Tectona grandis* are thick and broad so they cover the area and do not allow enough sunlight to penetrate through except in the months of December to February The absence of sunlight does not allow the growth of grasses even during monsoon months. Leaves though thick and broad do not form a substantial litter cover over the soil surface, because the litter is picked up or broomed by the inhabitants as this site is in the university campus. The leaves of Mango trees are heavy in weight but smaller in size. The leaf litter cover formed on the orchard floor was not very thick and during the months of March to September the litter cover was almost absent.

As a result the population of the decomposer community the Collembola was very poor, but the Acari mainly the Prostigmata mites were present in good numbers (Table 9f, 9i and Table 10f, 10i). The pterygote population was only represented by order Diptera, Coleoptera and few Hymenopterans at both the sites.

Selective grazing by springtails may be an important factor limiting the distribution of certain species of basidiomycete fungi in the field (Hopkin 2002); however at certain densities of

Collembola, grazing of mycorrhizae on roots can stimulate the growth of symbiont and improve plant growth (Gange 2000). Thus, the effect of grazing activity of Collembola on root fungi is totally density dependent. On the other hand, Collembola may reduce the disease by consuming pest fungi (Sabatini and Innocenti 2001).

The litter supported an array of mesofaunal organisms and the total number of insects and mites showed an irregular trend of seasonal fluctuation with mostly peaks in monsoon months. The acarina population in the litter was rich as compared to the collembolan population. The pterygote fauna was represented by good population of Dipteran adults, Coleopteran adults and larvae both the other members of order Isoptera, Pscoptera, Lepidoptera were in negligible amount. There exists a competitive interaction among plants and the soil fauna, but functional dissimilarity of the soil microarthropods have a great effect on the leaf litter mass loss and soil respiration (Heemsbergen et al 2004). These observations support our collection of soil microarthropods but as there organisms play a vital role in decomposition by fragmenting leaf litter and adding vital nutrients to the soil (Johanna and Renolds 2006) their numerical count is equally important.

The litter which provides a microclimatic niche for the microarthropods, some of them takes refuge, to counteract the adversities of unfavourable weather conditions (Desender, 1985) (some complete their life cycles under it). Most of the microarthropods also play an important role in litter decomposition especially the mites (Fujikawa, 1972). Litter decomposition is an important ecosystem process that makes nutrients available for plant growth (Coleman and Crosseley 1996). This process is controlled by three types of interacting factors: the physico – chemical environment, the substrate quality, and the biota (Swift et al 1979). Factors of the physico – chemical environment including climate and soil parameters determine the soil conditions for the process of decomposition. The substrate quality is mainly determined by the quality and type of the litter, and the chemistry of the litter, but it is only a predictor of variations in decay rate on local scale. Thirdly the biota which is considered to be most important factor in the decomposition process for any one leaf type under favourable conditions (Lavelle et al 1993). In the present study the amount of litter at the sites viz the Mango orchard and Teak plantation was negligible in the Mango orchard and thick in the Teak plantation.

On comparing the litter population of the two sites it is clear to some extent that the microarthropods are present in substantial amount with Acari being most abundant. The soil biodiversity is essential for the soil health and fertility and also for the plant growth; and the soil diversity is directly associated with the litter diversity and the litter itself, because the soil fauna decomposes the litter and in turn recycles nutrients to the soil ecosystem. The loss in biodiversity raises several questions, and one of major consequence of decreasing diversity is associated changes in ecosystem functioning because ecosystem processes depend on the presence of a specific number of functional groups, species and organisms.

According to Biologist biodiversity is essential; but according to Ecologist How important is biodiversity for ecosystem processes? and for the Pedobiologists primary productivity is important both in the above ground and below ground ecosystem processes. Therefore as we know that in terrestrial ecosystem above and below ground plant litter-input constitutes the main resource of energy, which is accomplished by a large community of soil organisms by decomposition of litter and recycling of nutrients (Wardle 2002, Bardgett 2005).

Our observations fall in line of Wardle et al 1997, Cornelissen 1996 that under given environmental conditions the litter quality and decomposers are directy related. The teak litter supports a good array of pterygotes and Collembola and in mango litter the mite population was on a higher side. The high abundance of mites is directly with improved, undisturbed microenvironment conditions, and Collembola was less as acarii feed on Collembola.

Seasonal variation is abundance of soil microarthropods is common (Wolda 1988). A sharp reduction in dry seasons and peaks in wet months, this suggests that moisture content do favours the population of soil microarthropods. The presence of good number of Pterygote adults and larvae from the litter samples of the two plantation sites clearly indicates the feeding habit of these insects and their role in decomposition of litter (Maraun et al 1999) though their feeding rates and habits may not be consistent throughout life cycles (Wallwork 1967). The litter population of order Diplura and Coleoptera in both the experimental sites was mainly the larval forms in abundance and adults in fewer numbers, with peak in monsoon months. This clearly indicates as soon as the moisture content of the litter rises (Table 4a, 4b) the populations of these insects increase. But the density of the population was also affected as this regions gets less monsoon shows and also very late, that in August and September. As a result the soil moisture remains in the soil till December and we have collected good number of Collembola in the month of December. During rainy season with the increase in moisture content of the soil Acarii and Collembola act as decomposers and their action in turn, increases the organic matter content of the soil which again promotes the growth of fungi (Carter 1980). These fungal mycelia are the sources of food for the Collembola and Acari (Fujikawa 1972). But at the mango orchard site as the litter is less hence the fungal mycelia was negligible and hence the population was also low comparatively.

Apart from seasonal variation, litter quality is also an important factor directly related to the population fluctuation of microarthropods. Because type of leaves the amount of nutrient they have and how easily the leaves are degraded after shredding by these insects is also very important. Leaves which decay rapidly are highly favoured by collembolans, coleopterans and hymenopterans, as it was observed in teak plantation site. The abundance of coleopterans adults and larvae at this site is due to the fact that Carabides, Staphylinids are potential predator on Formicides, Collembola and Dipteran larvae. Price and Benham, 1977, Darlong and Alfred 1982, was of the openion that the interaction of litter and soil apparently had its effect on the prevailing physico- chemical condition of soil. The thickness of the leaf generally influences the rate of decomposition which in its turn affects the fluctuation in the population of microarthropods in general and Collembola and Acarina in particular.

To sum up the discussions on the litter mesofaunal population, it has been observed that there is a general tendency in the increase in the number during monsoon months and low population in summer and winter months. The Acari are largest in number in both the sites but the order: Collembola is represented by five families (Poduridae, Isotomidae, Sminthuridae, Entomobryoidae and Onychiuridae) all in good number in Teak plantation and very less in mango plantation. Because collembolans show moist habitat preference and tend to migrate from the litter as there is less humus in litter, and less of humus less of fungal mycelia (Darlong and Alfred 1982). Diplua was represented by only one family: Japygidae in fewer numbers at both the sites.

The annual decomposition rates were significantly affected by animal exclusion, as we observed lesser population in mango plantation litter samples, because the decomposition ratio is positively correlated with the mean microarthropod or soil fauna diversity in the litter.

Soil fauna can influences litter decomposition by communities of litter or through interactions with microbes. The macrofauna such as Isopoda, Isoptera, Coleoptera, Hymenoptera and earthworms and the mesofauna such as oribated mites (the most abundant group of Acari) and Collembola, are important litter fragmentors or detrivors (Adl et al 2006). Therefore the soil food web is not limited by the amount of litter. However loss of litter layer or removal of organic matter in the long term affects the soil fauna (Bengtsson 1998). Plant litter can influence the activity of soil microbes and fauna by providing them with a food source and habitat (Zak et al 1990, 1994).

The summer minima in the total population of collembolans and Acarina though correlated with the dry conditions, lack of moisture high atmosphere temperature but the most important reason could be scarcity of food material. As in dry conditions the humus layer becomes dry and the growth of fungal mycelia is also retarded. The absence of fungal population in the soil may be one of the causes responsible for such a minima (Wallwork 1967). In conclusion there is a strong correlation between litter animal diversity and decomposition rate suggests soil animals play an important role in litter decomposition. We also made certain inferences;

a) That thickness of leaves has a relation with the rate of decomposition.

b) That there is a tendency to increase in the numerical abundance of most of the populations of litter-dwelling species, when there is enough fungal growth on the soil surface.

c) As these fungal mycelia dry up, the populations begin to dwindle. The plant cover over the patch of land can have an impact over the fluctuation of population of oil-dwelling forms. This is indicated in the populations of soil-dwelling species at site Mango Orchards which remained shaded for most part of the year, because of densely planted *Tactona* sp., the litter of which possessed the maximum number of mesofaunal species. Similar observations have also been made by Belfield (1970).

d) The ratio of numerical abundance values of collembolan and Mites shows that Mites are numerically greater than the collembolans. Similar results had been reported from other places of India.

Mineral Soil Population

Site Mango Orchards

The samples collected from the two different depths 5 cm and 10 cm keeping the objective in mind of assessing the population of microarthropods in the soil upto a depth of 10 cm. The soil microarthropods in the soil substratum settle and pass their life cycles partial or complete. The soil fauna is solely responsible for the decomposition process, a process which is an important function of the soil food web. By this process the dead and decaying plant and animal material is converted into organic matter. This organic matter being an important nutrient is made available for the next trophic levels. The litter if present on the surface of the earth is converted into humus. Humus is defined as "the total organic fraction in soils exclusive of non decomposed plant and animal material, their partial decomposition products and the soil biomass". Without humus the surface of the earth is just a mixture of weathered rocks and minerals. Formation of humus is dictated by many environmental factors. Many people believe that large amount of humus can only be formed in a warm liquid climate where plant growth is abundant. The annual turnover of dead grass makes large accumulation of humus possible. The humus content is the plantation area is less as compared to arable areas because large amount of organic matter is not recycled but retained in the big tree trunks. Hence the population of soil microarthropods is less than that in the arable areas.

Apterygotes, Pterygote larvae and Mites formed the core of the population of the animals species who are primary residents of subterranean stratum. The moderate population of collembolan obtained in the samples can be attributed to the total absence of litter. Such an effect has been noted by Jorjansen (1934) who opined that the decomposition of litters seem to be the directly involved in the formation of various animal communities. Similarly, Ford (1937) had emphasized on the influence of presence or absence of grasses on the fluctuation in the populations of Collembolan and Acarina. He obtained a February minimum which was in correspondence with the destruction of tussock structures. In the present study, a summer minima has been found in the population of the members of the Collembolan and Acarina families as mentioned in the tables (9d, 9e & 9g, 9h) during which the grasses dry because of intense heat and loss of moisture. The present observation related to the effect of vegetation on soil denizens is supported by Strickland (1947) who was of the view that vegetation had greater influence on the soil inhabiting insect population than the soil type.

The population of collembolans, dipteran larvae and Acari can be said to be a poor population as compared to a temperate region. The meager number of the forms obtained in the present study can be attributed to the facts that the paucity of humus in tropics resulting in a smaller population or arthropods in soil. Salt (1952) obtained the same results in his studies of soil from East African pastures. Hale (1966) in support of Dowdy has further strengthened the case that habitat has a pronounced effect on the life of Collembola.

This site supports the most diversified group of animals, their interrelationships assumes the significance of great ecological importance. Apart from termites which belong to the worker caste of odontotermis, the other Pterygote insects that were recorded were isopterans and dipterans. The collembolans were represented by the families namely Poduridae, Isotomidae and Entomobryoidae occurring more abundantly followed by Poduridae and Isotomidae. The Diplura was represented by a single species *Japyx* and in a very small numbers. Larvae of Scarabidae and Elateridae were the two representative of coleopteran. Among Dipteran larvae the larvae of Tipulidae were present in moderate number.

The Mite population comprised the member of suborder Cryptostigmsta, Prostigmata and Mesostigmata. The cryptostigmata mites were more numerious than the rest of the mites, however, Mesostigmates were closely behind the cryptostigmate.

Collembolans, termites, prostigmate and mesoatigmate mites face the predation risk from larvae of Scarabidae which also have a trend of increase along with these groups. Apart from carabides the collembolans, prostigmates and mesostigmate mites are prone to the predation of *Japyx* and gamsides which are predatory in habit. These two groups show a similar trend of increase during the months in which the collembolans flourish. Though it has not been possible to examine this assumption statistically but such an assumption is based on a food web envisaged by Carter (1980). This assumption is supported by Joose (1981) who emphasized that in a more stable and favourable environment biotic factors play a more direct role. A higher predation risk as he observed in the case of *orchesella cinecta* and an interspecific competition between two or more species of Collembola. These abundant soil animals has been observed as a source of food for the members of Coleoptera and

Hymenoptera as they not only prey on forest animals and plant materials but also dead ones as postulated by Kunhelt (1961) and Raw (1967).

The tables show a declining trend in the population density of soil insects and mites. Lesser number of isopterans were collected in deeper layer (10 cm), however, their maxima was similar to that of the upper layer {Table 7-8 (a-i)}. However, there are records of occurrence of different groups of arthropods upto the depth of 22.86 metres (Singh, Mukherjee and Singh, 1970).

The composition of collembolan was leading in number at this depth too. Diplurans were few in number but had a similar trend in their increase. The larval forms of the Pterygote comprised of larvae of Scarabidae and Elateridae though their number was same as that of the upper layer.

The collembolans due to their vertical distributions are present in high proportion in the upper most sub-samples of the total population. There are global reports about the decline in the number of collembolans with the depth by Murphy (1962), Poole (1959), Dillon and Gibson (1962), Davis (1963), Christenson (1964), Mc Millan (1969), Chaudhury and Roy (1967), 1971a, 1972) Takeda (1976), Darlong and Alfred (1982), and Mallow et al (1985).

Haarlov (1960) observed a correlation between the size of collembolan forms and their distribution according to depth and indicated that with increasing depth there was reduction in the soil pore space due to which the larger forms were unable to penetrate to the deeper layer. Further in this operation the depth distribution was related to feeding, temperature and humidity relationships of the individual species concerned. Walwork (1970) observed a humidity and or temperature relationships of Collembola which affected the choice of microhabitat in the soil profile. In the opinion of Dillon and Gibson (1962) the population decrease was related to decreasing porosity of soil. According to wood (1967) such a factor other than pore space determines the material distribution of Collembola. The present observations fall in the line of above quoted work. However, Mukharjee and Singh (1970) were able to collect soil microarthropods from a depth of 22.86 cm at Varanasi, Kaczmarek (1993) more than 90% of Collembola inhabit the top 10 cm of soil. Thus, soil cores of 10 cm depth were considered to be sufficient to sample most of the springtails, whereas Price and Benham (1977) have recorded the occurrence of collembolans and Mites from a depth of 299-311 cm in trenches and 114-122 cm from the pits. The decline in the collembolan population in the deeper layer because of the less porosity has been high lighted by Didden (1987) who performed several experiments to examine the validity of Usher (1976) hypothesis that aggregation of soil microarthropods can be caused by two factors location of food sources – physical environment. Didden, found that the factors like food temperature and humidity are not to be taken as factors stimulating aggregation and according to him pore structure remains the only factor that influence the favourability of the environment.

Site Teak Plantation

As compared to site Mango Orchards this patch of land remains shaded throughout the year though litter fall is there but the shade does not allow the growth of grasses even during monsoon months. This patch of land is approximated from one side by the sloppy land. During summer the roaming cattle usually sit under shade and hence cattle droppings have been commonly encountered.

There is a trend of increase in Isopteran population. Among Pterygote larvae Scarabaeidae larvae have been encountered for the first time. Larvae of Elateridae have also been collected. The Apterygote population is more or less identical but slightly on a lower scale. Monsoon maxima here too had been observed. Similar trend observed by Darlong and Alfred (1982) The occurrence of high population during rainy season was due to the excessive moisture content in the soil and winter minima was due to desiccation of soil combined with low temperature. Similarly N'Dri and André (2011) mite densities were higher during the rainy season than during the dry season. The Acarina population at this site revealed a slight increase in the number of Cryptostigmatids. This increase in number of Cryptostigmatids may be attributed to the decomposing leaves which remained adhered to upper soil layer. The prostigmate which were lesser at site Mango Orchards. In the same layer Mesostigmata followed and the reason for the similar trend of increase seemed to be the same.

The springtails exhibited a winter maxima and mites exhibited a monsoon maxima culminating a July maxima. A smaller winter in January has also been observed. The biotic factors which may be accounted for lower number of Collembola at this site inspite of liter deposition may be attributed to the preponderance of Staphylinides. Scarabide larva which has been collected from this site may account for reduction in the collembolan population. The shades of the trees reduce the rate of evaporation and hence the moisture allowed the presence of fungal mycelia almost throughout the year. This was the reason for abundance of termites which were present in greater number than site Mango Orchards. As indicated in the proceeding pages a competition between isopteran and collembolans is not ruled out.

In the deeper layer (5-10 cm) a slight increase in the number of soil insects and mites had been observed as in the case of site Mango Orchards. Similarly reported by Macfadyen (1952) The population of the fauna was largely confined to the upper 5 cm of the soil but in the winter some species penetrated further into the soil. The author observed a regular seasonal difference in population size as shown by most species, they involved an August minima and a February maxima, there were also lesser maxima for some species in December as May. There was relatively little variation in the species composition throughout the year. During his studies the author was able to collect large number of Oribatid, collembolans, Thysanoptera, Coleoptera adult and larvae and dipterans larvae. Hale (1966) an adverse weather conditions caused a vertical migration as there was higher proportion of Collembola in a lower of the two layers in early summer and winter. The population diminished in the upper layer of the soil because of vertical migration but possibly as a result of differential morality or both. Kaczmarek (1993) who suggested more than 90% of Collembola inhabit the top 10 cm of soil. Thus, soil cores of 10 cm depth were considered to be sufficient to sample most of the springtails.

The Pterygote population included the worker of Termites lesser in number, larval forms of coleopteran represented by family Scarabaeidae and Elateridae. Carabide larvae had not been collected from this site at this depth. The presence of Scarabaeide larvae at both the depths indicated that the cattle droppings were conducive to them. As compared to site Mango Orchards the larvae of Scarabaeidae were numerious at the same layer of the soil. The Diptera were represented by the larval forms of family Tipulidae.

The collembolan population too exhibited a similar trend except for the family Isotomidae. Isotomides are known to inhabit deeper layers. But according to Price and Benhan (1977) population densities of microarthropods (Acarina, Collembola, Pscoptera, Pauropoda, Protura, Symphyla, coleopteran and dipteran larvae and Diplura) decreased gradually with the increasing depth. The Acarina population too went in descending order.

The factors affecting the distribution at lower level of these forms may be biotic and abiotic both. The soil organisms exert a major control over many soil processes through their effects on decomposition and nutrient cycling. The activities of these soil organisms interact in a complex food web. In this complex food web there exists a dynamic balance between the different groups of organisms with different feeding habits. Predation and competition are the main factors controlling this equilibrium. The collection of good number of Dipteran, Coleopteran and Lepidopteran larvae supports the hypothesis of earlier workers that these coprophagus organisms clean the soil surface and incorporate organic matter into the soil.

The presence of few nematodes, earthworms and good numbers of termites in the upper layers of soil suggest that nematodes being the clearing agents, earthworms determine the vertical repartition depth in soils and termites form galleries in the compact soil for the circulation of water air and other organisms.

Site Unarable Land

This Site was an unarable patch of land with undulating surface and experienced much human and cattle interference. The uncultivated land or unarable land contains more population of microarthropods than in the arable or cultivated land (Buckle 1921, Burnett 1968, Edward and Lofty 1974). All the Pterygote orders were nicely reported by both adult and larval forms with a monsoon peak. Order Isoptera outnumbered the other members of the soil community both at 5 cm and 10 cm depths. The Apterygote showed interesting results with order Collembola family: Poduridae having maximum number in January, February and March and sudden decline in monsoon months where as the acari was in good number throughout investigation period at both the depths.

The soil at this patch of land seemed to be more compact and we assumed in the accordance with Didden's experiment which elucidated that the collembolans tend to migrate from compact soil to loose soil. In absence of nutritional base the microarthropods migrate to the places in search of a place rich in energy and nutrient sources as observed by William et al (1987). They postulated that under food stress the microarthropods developed diurnal diagonal species which are capable of cryptobiosis. No-tillage is one of the most sustainable soil management systems in that it increases soil organic matter, improves soil quality, reduces labour requirements and machinery costs, reduces fossil-fuel inputs, increases available plant water by reducing runoff and soil erosion, increases available plant nutrients, and improves the global environment (Phillips and Phillips 1984, Sprague and Triplett 1986, Reeves 1997, Reicosky and Saxton 2007). The populations of all the groups of soil microarthropods at this site show an interesting pattern. There were numerous Coleopterans larval forms the Isopterans outnumbered every order, both the depth 5 cm and 10 cm (Table 11a, 11b and 12a, 12b). This observation is in conformity with the observations of workers on Coleoptera in general. The Carabide beetles require vegetational cover to protect themselves from adverse atmospheric conditions as this site was devoid of tree shade or any type of vegetation cover, the population of Carabidae larva was less at 5 cm depth and very less at 10 cm depth. Simultaneously larval forms of family Scarabidae were found especially under cow dung deposition, as this area is an open area used by students and also stray animals wander through, so dung deposition was seen here and there. Scarabide beetles are coprophagus- they are very efficient at incorporating and removing excrements that are on the soil surface. For examples a couple of *Heliocopris dilloni*, a large African species, can burry a piece of dung in one night. Carabidae and Scarabidae are pest predators and because the site is devoid of any type of crop, plantation or grasses or vegetation presence of pest is rare. Coleopterans on the whole are considered to be an indicator of soil degradation, a process which is related to soil health. The population of termites was significantly high as compared to other groups/orders.

Termites which are also called as white ants are highly socialized insects, feeding usually on dead wood and litter, chemically their food is cellulose but some termites are known to feed also on lignin. It is believed that digest the lignocelluloses compounds with the aid of protozoa and bacteria in their intestine. Because of this symbiotic relationship termites are considered to play an important role in nutrient cycling (Lavelle and Spain 2001). Some termites are also soil-wood feeders and soil feeders; this means they ingest a high proportion of mineral material. This proves our observation that the high population of termites collected from this unarable land that they were humivores. Termites are important ecosystem engineers promoting soil fertility and may reach high densities. They also influence (I) soil porosity and texture through tunneling, soil ingestion and transport and gallery construction; and (II) nutrient cycling the transport, shredding and digestion of organic matter.

Acarina was represented by all the three suborders in moderate numbers throughout the investigation period. The moderate population of mites leads to a conclusion that the site is unarable devoid of vegetation, moisture and organic matter. The presence of dipteran and coleopteran larvae also add to their low population, as they feed on the mites. The only reason which favours the presence of mites is that the site is undisturbed that is no tillage, no manuring, no ploughing or chemical spraying. Multiple peaks are very rare in soil mites. Most genera of mites have only one peak which coincides with same time of the year (Badejo 1990).

Lastly the Apterygote insectan population showed very interesting and fluctuating collembolan population. The order was represented by all the five families but family Poduridae and Isotomidae showed remarkable peaks in the months of January, February and March, consecutively for two years and very meager population in rest of the months at 5 cm and 10 cm respectively. The probable reasons for such a data could be abiotic edaphic factors as well as some biotic factors. Seasonal distribution of collembolans reveals that different species reach maximum and minimum number at different times of the year (Hale 1966). Population fluctuation may reflect species specific life history strategies as adaptation at various soil horizons (Van Straalen 1989). Multiple peak population is often due to iteroparity (repeated reproduction) (Mitchell 1978). It is known that many species of springtails are interoparious and potentially multivoltine. This is illustrated by the findings of various workers on springtails population (Butcher et al 1971, Joose 1981 and Van Straalen 1985, 1989). Collembolans try to avoid desiccation by migrating from the place for sometime hence in dry months the population is very low because in the absence of vegetation there was no shade and high atmospheric temperature reduces the soil surface.

Site Wheat Field

Soil microarthropods (principally mites and collembolans) are among the unseen faunal diversity in nearly all agricultural soils. Microarthropods participate in the complex food webs of soils but their importance is seldom appreciated. (Crosseley et al 1992). The third experimental site was an agricultural field where wheat was the only crop harvested rest of the year the field is left barren without any cultivation. For wheat cultivation the ploughing was done with the help of tractors, and then during cropping light tillage was done along with the use of chemical and organic fertilizers. Pesticides and insecticides were also sprayed before harvesting. Altogether this area remained under human interference for a very long time. The harvesting period also lasted for December to April months. The ready crop was left in the field for quite some time. After that the field was left vacant till the next sowing season. Now this character of the experimental site had a profound effect on the below ground faunal composition and their population dynamics. The population of soil microarthropods collected from the two different depths (5 cm, 10 cm) is different in quantity and quality.

The Dipteran adults were more in 5 cm depth than in 10 cm, whereas their larval forms were more at 10 cm depth. Coleoptera were same at the depths, Hymenopteran adults were collected in large number at 5 cm and were absent in 10 cm. Lepidoptera was another important order which was represented by larval forms in good number at 5 cm. The collembolans were very few in number at both the depths in 2008-09, but in 2009-10 all the families were present though in few numbers. Similar was the case regularly Acarina population though the number was good. (Figure 12j, 12k and 16,16k).

Observing the population which we encountered during our study it is clear that the population of below ground fauna do gets disturbed by human intervention. The population of termites was low as the field is taken care for commercial purpose. Formicides were extracted in abundance with peak in monsoon months. Mola et al (1987) have reported that population of Collembola is directly affected by tilling or by the use of insecticides. The population of Collembola was very low at 5 cm depths in the first year but in the second year the population was somewhat substantial, this gave us a que that the collembolans tend to recolonize. Though cultivation eliminates the population of most of the microarthropods species that have to disperse during disturbance but recolonize (Wardle et al 1999) because agricultural intensification is not consistently harmful to the soil fauna that soil associated microarthropods are most responsive to management practices which affect the nature and quality of resource input and the long term exploitation. Further the impact of agriculture practices are experienced more by some groups of microarthropods than by other. Earlier Sheals (1957) and Edward and Lofty (1974) reported reduction in the soil animal population immediately following cultivation. In our investigation Collembola was poorly represented as compared to other Pterygote insects and mites that within the same group of animals the impact of agricultural operation can be of different degree on different taxa.

Regarding the methods of cultivation, management practices employed by the farmers, pedobiologist have reported that the population of soil microarthropods is comparable between manual and mechanical tillage, tillage and no tillage also. Mechanical tillage destroys the preexisting plant cover or vegetational ground cover which in turn can change the structure of the soil and soil associated animal population (Ghilarov 1973, Darlong and Alfred 1982). The abundant population of mites showed that ploughing had not affected Orbatids, which can be explained with the beneficial effect of ploughing on soil structure. In some instances collembolans had been found to recolonize either by tilling or by use of insecticide (Mola et al 1987, Resilda et al 2002) but in our observation this process was very slow as after harvesting few more collembolans were collected. As there was enough use of inorganic fertilizers which implied negatively on the population of Collembola and other soil microarthropods. The role of soil microarthropods is directly affected by the management practices employed Farmers need to create favourable conditions for soil life. There is strong contrast in the population dynamics of the field which are managed conventionally and non conventionally. The conventional tillage practices, based on the use of hand hoes, plough – animal drawn and powered and harrows are likely to destroy soil structure and make the soil vulnerable to compaction and erosion. Wheel traffic or pressure excreted on the soil surface by large animals, vehicles and people can cause soil compaction. Compaction occurs where moist or wet soil aggregates are pressed together and the pore space between them is reduced. Compaction changes soil structure reduces the size and continuity of pores, and increase soil bulk density. It reduces the capacity of the soil to hold water, when less water is available for plant growth it decreases soil organisms. Non conventional management employs mechanical tillage which is altogether harmful for the soil fauna. It can kill them outright, disrupt their burrows, lower soil moisture, and reduce the amount and availability of their food. When the population of tillage and tillage plots were compared it was found that the diversity and population of the soil fauna and the microarthropods was on the higher side in no tillage plots (FAO Report 2000). The natural predators such as the mites, coleopteran and dipteran larvae and the decomposers such as collembolans are directly benefitted from no tillage. Therefore in contrast to ploughed systems, no tillage management leads to accumulation of plant residues on the soil surface. This decreases the rate of decay of crop material and therefore, helps to maintain good soil organic matter levels.

Agricultural intensification involves high input application to replenish soil fertility, especially the use of inorganic fertilizers (Shriar 2000 and TSBF 2003) continued use of inorganic fertilizers has not only altered the soil pH, structure and texture but also disrupted the niches for the microarthropods which as essential for nutrient recycling (Ponge et al 2003 and Moreira et al 2006). Earlier it was reported that the addition of organic fertilizer to industrial waste lands increases vegetation cover, which can increase species richness and abundance of soil animals (Kampichler et al 1999). The low population of Collembola proofs the hypothesis of Axelsen and Kristensen (2000) that Collembola are abundant in agricultural soils that are framed organically. This wheat field which is conventionally managed that is mechanical tilling, followed by manual tilling addition of chemical and organic fertilizers, manual weeding and use of pesticides and insecticides. All this has become a part of industrial agriculture which relies mostly on inputs off farm products such as pesticides, herbicides and fertilizers (Horrigan et al 2002, Tu et al 2006). Although this management practice has played a major rple in the improvement of fiber and food quality as well as productivity, practices employed have raised numerous public health and environmental concern (Horrigan et al 2002). The current conventional management practices have an adverse effect on biodiversity (Moffat 1998), agricultural ecosystems and its immediate environment. Biodiversity is also important in maintaining resilience (Spratt 1997) i.e. the soil capacity to recuperate its initial situation after a natural or human induced perturbation. The soil biodiversity though less studied but holds greater importance. The soil which is most precious resource needs to be protected by taking care of its biodiversity also. The sustained biodiversity also sustains the plant cover and to maintain this relationship successful adaptation of agroforestry systems in dry soils by amelioration of soil structure and fertility by using animal manure.

Agricultural system that use organic amendments tend to enhance crop diversity and soil fauna biomass. The soil fauna biomass is mainly represented by the decomposer biota, which have a major role in regulating the structure and function of the agricultural ecosystems (Beare et al 1997). Biological, chemical and physical properties of soil vary both in time and over space. This spatial characteristic of the soil resources is an important contributor to the communities because of better resource partitioning (Giller 1996, Ettema and Wardle 2002). Several ecological factors can influence the activity, ecology and population dynamics of microorganisms in soil. Associated with the biodiversity of the soil is the soil resilience to endure disturbance (Nannipieri et al 2003).

The diversity of life in soil, known as soil biodiversity is an important but poorly understood component of terrestrial ecosystems. Soil biodiversity is comprised of the organisms that spend all or a portion of their life cycles within the soil or on its immediate surface including surface litter and decaying logs. The beneficial effects of soil organisms on agricultural productivity that may be affected include:

- organic matter decomposition and soil aggregation
- breakdown of toxic compounds, both metabolic by products of organisms and agrochemicals
- inorganic transformations that make available to nitrates, sulphates and phosphates as well as essential elements such as iron and manganese
- N-fixation into forms useable by higher plants.

EFFECT OF EDAPHIC FACTORS

Soil microarthropod communities are influenced by some selected factors which also influence above and below ground animals. Species richness and the biological success of specific communities are positively related to the diversity of niches and soil microenvironments (Van Straalen 1997). As a result, the cropping diversity, rotational regimes and soil preparation and the dynamics of microenvironments in the soil tremendously affect soil arthropod populations (Pankhurst et al 1997). Improved knowledge of such microarthropods is the current need to increase our understanding of population responses to disturbance and impact of edaphic factors in soil environment. We believe that differences in dispersal rates of soil faunal species are likely to be strongly correlated with the differences in their population's response and with other factors temperature, soil moisture and organic matter. Soil organisms are subjected to a variety of selective edaphic factors in the soil environment; however the effects of these factors on the diversity of soil microarthropods and their interactions is difficult to predict because of the dynamic nature of their diversity in an ecosystem environment. The effects of edaphic factors on the diversity of soil microarthropods may be more subtle but equally significant from the stand point of long-term ecosystem structure and functioning.

Effect of Soil Temperature

Among the edaphic factors studied temperature showed a marked variation with the change of season ranging between 15°C to 41°C. Physical factors like temperature and moisture being interlinked are perhaps indivisible in natural conditions. Webb (1970) has observed, "During hot dry months population number are low and this could be attributed to a direct effect causing inactivity and death of mites". Ashraf (1971) said that 30°C was the optimum temperature for the species of Collembola (*Salinamultiseta, Isotomurus punctiferus* and *Seira iricolor*). In the present investigation it may be noted that direct influence of temperature on distribution pattern is difficult to evaluate because in this study the insects belonged to different orders, have different temperature preferences. In the case of Isopterans, Rajagopal (1983) stated that the population density and fluctuation in cast composition with seasons vary from species to species. As for scarabaeides the larval forms which are commonly known as white grube, Ritcher (1958) stated that the length of pupation period varies with temperature being 3-4 month at 12°C and 4-5 weeks at 20-25°C. Veeresh (1977) stated that even in the presence of adequate soil moisture adults do not come out of the soil unless the gonads fully nature which can happen only when the soil temperature raises at 23ºC in the case of *Holotriehia serrata.* Similarly the mites belonging to family Eupodidae, Rhaghidiae and Parasitidae are most abundant winter active group irrespective of temperature (Aitchenson 1979) and the oribated mites thrive well in desert soil where the temperature change varies from 40-50ºC (wallwark et al 1986). Collembolans are known to withstand a wide range of temperature from -4ºC (Aitchenson 1979) to a temperature of 55ºC in desert (William et al 1987). Earlier reports of thriving of Collembola at 55ºC by Dunger (1964) Agrell (1941) Belinger (1954) Davis (1963) Takeda (1976) reported the high rate of mortality of some forms of a temperature range between 34ºC–40ºC. Similarly Choudhary and Pande (1979) have noted that there was cessation of oviposition in the case of *Lobella* sp. at 35ºC. According to Hubta and Milkonn (1982), in the case of *Entomobroya orchecella* and *Lepidocrystus,* the lower temperature caused overwintering in collembolans. *Tomocorus* reproduced continuously in several webs during summer so that population consisted of many age classes. Christainson (1964) have quoted that temperature regulates the reproduction of springtails, but the role of moisture is equally important in regulating and synchronizing the reproductive activity hatching and mortality in many Entomobryoides. According to them because the rate of development in Collembola is directly related to temperature the growth of individual should be more expediated in clear cut area than in the forest owing higher temperature in the areas. Takeda (1981) has been suggested the seasonal changes in abundance of Collembola in north-east Thailand and reported that the population of Collembola abundances increased in the wet season and decreased in the dry season. According to Kardol et al (2011) Collembola abundance and richness were positively related to soil moisture content, and that negative relationships between collembola abundance and richness and soil temperature could be explained by temperature-related shifts in soil moisture content.

In the present investigation the highest population was recorded in December to February when the mean value of temperature ranged between 17ºC–24ºC. But the population decreased in the summer months (April and May) when the temperature shoot up and reached the highest level 34ºC. Thus, we agreed with the observations of some previous researchers that they stated the same findings (Takeda 1981, Kardol et al 2011).

The present observations deviate from the observations mode by Hubta and Milkonn in the fact that more collembolans were extracted from the forest area than in the fallow land. The results obtained in this study were subjected for statistical analysis for finding out the regression and correlation between soil microarthropods (collembolans, dipterans, Mites and Pterygote larval population) and the edaphic factors (Temperature, Moisture and Organic Carbon). It was made clear by interpreting the regression lines and coefficient of correlation that the correlation between apterygotes and temperature did not indicate significant correlation in all the working sites at all depths and in litter also except some cases. The mites and collembolans showed negative correlation with all the sites at 0-5 cm depth and litter. Regarding Mites and Dipterans they, also showed the similar trend. The pterygote larval population showed negative correlation in litter, but less significant at 0-5 cm depth with temperature. The present observations fall in the lines of Durant and Richard (1966) who concluded that population of soil microarthropods showed no significant correlation between the collembolans and soil temperature. The August maxima and summer minima of Collembola and Acarina population has been reported by Singh (1970). A monsoon maxima has also been reported by Choudhary and Roy (1972). Singh and Pillai (1980) too had reported population maxima in the month of Juy and August and reaching minima in April and May. Mallow et al (1985) has reported a July maxima for Acarina and August maxima for Collembola. Different authors have found collembolan and Acarine population peeks in winter months November to February. Thompson (1924), Ford (1937), Dowdy (1965), reported peaks in June with minimum levels in December. Edward and Thompson found collembolan population maxima during spring and fall. According to Johanna and Reynolds (2006) soil microarthropod populations, which play a critical role in decomposition by fragmenting leaf litter and adding vital nutrients to the soil. Preliminary results indicate high soil microarthropod abundance when soil temperatures are moderate.

The rise of temperature is expected to cause greater evapouration from litter making it dry and hence minimum population in summer is generally attributed both to the litter and soil mineral layer. The negative correlations shown by temperature may be explained in terms of the fact that it cannot be evaluated unless it is considered in conjunction with atmosphere.

Effect of Soil Moisture

Ecological studies on soil invertebrates have identified various factors influencing the population densities and fluctuation of these animals. Soil moisture is considered as the most important factor for those species that cannot withstand low humidity such as collembolans. Soil moisture determines the suitability of a habitat for species with certain ecological strategies (Joose 1981). The soil moisture is an important factor governing the survival of the soil biota. The moisture content of soil exhibited a wide range of variation (Minimum 0.3% and maximum 4.28) Moisture has a far reaching consequence on the population densities of soil denizens. Increase in moisture promotes the growth of fungi which is the chief food for termite collembolans and oribateid mites. The luxuriant vegetational growth during monsoon provides a cover for many cursorial forms as well as it enhances the rate of decomposition of litter and increase in the layer of hurices over a top soil. In all the cases of observations the population of Pterygote larval forms and adult population was found to be maximum in the monsoon months which prolonged upto August in this part of the country.

Similarly the mineral soil population exhibited the same trend. Singh (1970) was of the opinion that there is certainly a correlation between moisture content and population dynamics of soil arthropod in his study of soil arthropod population in rose garden at Varanasi. The results obtained in this study agrees with those of Agrell (1941), Poole (1961), Knight (1961), Pryor (1962), Janetschek (1963), Davis (1963) and Choudhury and Roy (1972), Hubta and Milkonn (1982); Darlong and Alfred (1982) and Mallow et al (1985). However, Hammer (1953); Dillon and Gibson (1962) and Davis (1963) reported negative correlation of some forms of soil mites with soil moisture. Macfadyen (1952) found no association of moisture with the population. According to Bandyopadhyaya et al (2002), each crop showed a rise followed by a decrease in collembolan populations. When crossed with crop effects collembolan populations showed a negative correlation with soil temperature and a positive correlation with soil moisture. Application of organic manure induced an increase in the population but the effects of fertilizers and other treatments applied to the field were not as significant as seasonal and crop influences. Tripathi et al (2007) the population showed a significant positive correlation with soil moisture. Badejo and Akintola (2006) the relationship between soil moisture content and the density of microarthropods within the 0-5 cm soil litter. The work became imperative In view of the numerous benefits accruing from the continual presence of soil microarthropods to the field of Agriculture and ecosystem balance. In the opinion of Haarlov (1960) the favourite habitats of microarthropods were characterized by stable humid conditions with plant material available all the year around. The marked increase of the population in all the groups under study in the monsoon months, perhaps suggested the probability of the existence of the forms having some preference for moisture conditions which nature in a tropical country like India. Besides this, the variable capacity of the Collembola and Acarii to withstand the condition of desiccation or draught occasionally is prevailing in nature. The regression of soil moisture content and temperature on numbers of collembolans extracted from the soil as well as the regression of relative humidity on a number of trapped epigeal Apterygote are presented in Figure 23-30. There were significant correlations ($r = 0.58$, $r = 0.69$) between % moisture content and number of springtails. Collembola have been reported to have a low resistance to desiccation (Joose 1981). This must have been responsible for the reduction in activity of epigial springtails in the dry season. However, reduced activity is not necessarily due to mortality. It could be due to survival mechanisims such as reduction in reproduction rate, migration to more humid places, and ecomorphosis (Butcher et al 1971).

Similarly, in dry and wet seasons densities of collembolans extracted from soil confirms the ability of springtails to adapt one way or the other to dry conditions. (Choudhury (1963), William et al (1987), Wallwork et al (1986)) might also be considered as one of the factors contributing to the population fluctuation. From the informations available till date, it might be assumed that the moisture content of soil exerted a direct/indirect influence on the soil insectan population:-

1) *by maintaining the soil reaction*
2) by controlling humification and turbification
3) by stimulating the growth of micro and macroflora

The statistical analysis for finding out the regression and correlation between soil microarthropods (Collembola, Diplura, Mites and Pterygote larval forms) and soil moisture revealed a positive correlation between Collembola and soil moisture.

Effect of Soil Organic Carbon

The contents of organic carbon varied between 0.2–1.16% and exhibited a strong positive correlation with the soil dwelling pterygote larval forms, Apterygote forms like Collembola and Diplura and among the Acarina.

It might be assumed that in some instances wetness or dryness as such influences the soil fauna indirectly rather than directly, since this factor largely determines the type and density of the vegetation which in turn contributed towards the augmentation of soil organic matter. The later not only served as a source of food but influenced the amount of living space available for soil living animals. The increase in population with the increased organic matter in soil has been reported in past by Haarlov (1960), Davis (1963), Singh (1970), Choudhury and Roy (1972), FujiKawa (1972), Singh and Pillai (1980), Darlong and Alfred (1982), Hubta and Milkonn (1982), Mallow et al (1985), William et al (1987), Bardgett (2005), Tripathi et al (2007), Wachira (2009), Yaang and Chen (2009), Muturi et al (2011). Moreover the concentration of larger population of Apterygote, Pterygote larvae and Mites in the liter and humus layer suggested their affinity to organic matter. The texture of the soil seemed to influence the amount of organic carbon. Dmowska (1995) Collembolans are important members of the soil mesofauna and play an important role in organic matter decomposition in soil. Rodriquez (1964) has observed large populations of various soil mites on the surface of soils particularly that of organic nature. According to him, organic debris of any type and its associated micro-organisms on the surface provide the necessary substrate for saprophagous and mycetophagous mites. This might account for the abundance of mites and insects in the litter and 0-5 cm layer of soil found in the present investigation.

Effect of Soil pH

Soil pH has been identified as the principal indicator of the chemical characteristic of a particular soil (Sinsabaugh et al 2008). It plays a significant role in all biogeo-chemical process. It influences the solubility of soil macro and micronutrients and essential elements. Acidification of the soil results in leaching of nutrients which in turn effects plants growth. The values of pH of soil samples basic ranging between 8.2–9.9%. According to Davis (1963) pH variation cannot be separated from that to variation in organic carbon and porosity as these are all closely linked. The range of pH 6.2 to 7.2% as found in the present study appears to be well in tolerance to most of the species of Collembola as reported by Frenzel (1936), Strenzke (1952), Choudhury and Roy (1972) and Vlug and Borden (1973). Van Straalen (1998) also reported that long-term acid deposition depletes soil buffering capacity and eventually decreases soil pH. This change is potentially harmful to many soil animals.

In the present study when the population attained the peak the mean value of pH ranged between 8.7–9.8. Bath (1980) performed an experiment when he treated the soil with H_2SO_4 and obtained the following results:

1) the rate of decomposition was lower
2) population of microarthropods was reduced
3) population of Collembola namely *Hypogastrura* sp.,

Isotoma sp. and Mesostigmata, Prostigmata, Cryptostigmata and Cryptostigmata and Astegmata changed and he concluded that its acidification may have marked influence on the below ground ecosystem. So it would be reasonable to believe that more or less neutral pH was favourable for the population of Pterygote larvae, Collembola and Acarina. This agrees with the hypothesis of Agrell (1941), Dillon and Gibson (1962), Davis (1963) Edward and Lofty (1974). This would be clear from the present study and also from the data presented by the previous coworkers that the pH had very little or no direct effect on the Collembola population, but it might contribute to the fluctuation of population by indirectly influencing vegetation and other physico-chemical properties of the soil. The present asseumption fall in the line of Bath (1980).

It would be perhaps clear from the above account that soil was a very complex habitat having its various factorial components intermingled with each other in such a manner that it was difficult to consider their effects separately. It might be inferred that the factorial components evaluated here in conjunction with other components not considered in this study collectively contributed to the population fluctuation and distributional pattern of insects and mites in the tropical climate of this part of Uttar Pradesh, India. Choudhury and Roy (1972) rightly pointed out that any attempt to unravel the interaction between edaphic factors and population of soil insects and mites would be abortive unless the behaviour of individual species in relation to each factor was studied separately under controlled condition in the laboratory. The present author has not ventured to do so as large numbers of species were considered and this attempt could not have been completed within a stipulated period of Two years.

The results of this thesis mostly corroborated those of earlier workers unlike in certain aspects there was deviation from the earlier work. The discrepancies might be due to the prevalence of local microclimatic factors which were likely to exert profound influences on the pattern of population structures (wallwork 1970).

Effect of Soil microelements

Phosphate: Now it is an established fact that phosphates which are available both in organic and inorganic form in the soil significantly influences the growth of vegetation. The organic compounds of phosphates usually form constituent part of humus complex of the soil. In this study phosphates were less in the soil and ranged between 3.01-16.77% throughout the period of investigation (March 2008 – February 2010) in all the sampling sites in Figure 10a-d (v).

It seems that there was no marked variation between phosphate constituent of soil so a relationship between soil faunal population and the phosphate has not been worked out. Choudhury and Roy (1972) observed either positive (Strong or weak) as negative correlation of collembolan population with phosphate contents. From the authors result it might be suggested that relation between the soil phosphates were not regular and consistent perhaps due to the fact that all of the phosphates in the soil was not available to the living system. The term available really referred to these phosphates which readily stimulated the growth of the plants, the availability of which would again depend on pH and concentration of organic matter. The author assumes that the phosphate as single factor didn't exert any significant influence on the population but it in combination with other factor might contribute to the fluctuations of other factors.

Available Nitrogen: The concentration of available nitrogen in the sampling sites under study varied between 93–375 ppm. And there was a slight increase with the onset of rainy season when the collembolan and acarine population also became numerically high. The breakdown of arthropod excuvie by bacterial action starts in the rainy season and for this reason the nitrate content of the soil increases. Belfield (1970) has observed excreta of arthropods, unaffected by the bacteria during dry season when subjected to rapid bacterial action induces population rise through increase in nitrogen content. Wachira (2009) High organic matter, shade, high soil carbon and nitrogen have a significant influence in supporting high population of soil Collembola and Mites. The presence of organic manure resulted in an increase in the abundance and diversity of total collembolan. According to Kunhelt (1961) Nitrogen acts as an attractant for the arthropods. The nitrate being the most essential macronutrient for the plants probably exerts its influence on soil insect and mite population through vegetation. In the monsoon months increase content of moisture brings acceleration in the rate of decomposition and ammonification. However, there are reports that increased Nitrogen content in the soil is deleterious to the population of soil arthropods namely Collembola, Acarina, Dipteran larvae and Coleopteran population. Many agents in the slurry may be involved but perhaps the greater significance in ammonia to be extremely toxic to wide range of soil arthropods. The author assumes that this might be a reason for a low population of soil insects and mites in site Wheat field. Eaton and Robert (2006) Physical litter characteristics, nitrogen, phosphorous and carbon to nitrogen ratio were significantly correlated to collembolans population. They have also brought into light the fact that evaporation of ammonia from farmyard manure has changed the nitrogen conditions of many temperate falls of Northern Europe. In their opinion fungivorous Collembola play an important catalyzing role in Nitrogen mineralization and in both deciduous and coniferous forest, Collembola in large microbial activity and decrease leaching of nutrients. These works clearly indicate that the content of nitrate brought about appreciable changes in both the micro and macroclimate thus resulting to population fluctuation.

Potassium: Plants absorb large amounts of potassium, all of it in the form of K ion. The positive charges of the potassium cations help to maintain electrical neutrality in both soil and plants by balancing the negative charges of nitrate, phosphate and other anions. Thus, plants require relatively large amount of potassium and often could benefit from more potassium than the soil can supply. Therefore, potassium is the third most likely nutrient element to limit plant growth (Frederick et al. 2005). According to our investigation, potassium ranges between 168-728 ppm in Figure 10a, b, c, d (iv). An interesting opinion from our study is that the adding potassium fertilizer to a potassium deficient soil will increase the crop yield. However, the timing of potassium fertilization may or may not be critical, depending mostly on soil and varied climatic conditions because, high potassium concentrations in sandy soils in humid tropical climates may be depleted by leaching before crop needs are met.

SOIL FOOD WEB

The insect communities under discussion can be referred as assemblage of microarthropod population in all the experimental sites in different population size and different time. In the present study the resources in all the experimental sites present a soil biodiversity with respect to taxonomic identity of the vegetation. The two plantation sites have different type of plantation altogether and the management of the area also is not the same for the two sites. The agriculture field which is regularly ploughed and irrigated both manually and mechanically is a disturbed site with different type of vegetation. Regarding the fourth site which is an unarable land, devoid of tree shade and any vegetation except for few patches of perennial grasses. The samples collected over a period of two years from four different habitats, have given us a picture of the population of soil mesofauna to large extent. We have assessed various abiotic soil parameters, along with the climatic conditions throughout the sampling period. The population of soil microorganisms has given a clear picture that there exist a definite food web in the soil. We tried to work out the nature and type of the food web in the sub soil ecosystem.

Soil is still a porous, semi aquatic medium within which temperature and moisture conditions are highly buffered. Soils were among the first terrestrial environment to be colonized because they possess environmental conditions that are intermediate between aquatic and aerial media (Lavelle and Spain 2001). Soil communities are among the most species rich compartments of terrestrial ecosystems (Andersons 1975). A food web is a heuristic concept map that depicts feeding connections (who eats whom) in an ecological community. The members of the food web are categorized as (1) autotrophs and (2) heterotrophs. To maintain their bodies, growth, development and to reproduce autotrophs produce organic matter from inorganic substances, including both minerals and carbon dioxide. These chemical reactions require energy, which mainly comes from the sun and largely by photosynthesis. The heterotrophs obtain organic matter by feeding on autotrophs and other heterotrophs. Therefore, linkages in the food web illustrate the feeding pathways in an ecosystem. These feeding relations are roughly divided into herbivory, carnivory, scavenging and parasitism.

An incredible diversity of organisms makes up the soil food web. They range in size from the tiniest one celled bacteria, algae, fungi and protozoa, to the more complex nematodes and microarthropods, to the visible earthworms, insects, small invertebrates and plants. The soil food web is the community of organisms living all, or part of their lives in the soil. The soil food web starts with organic matter. This could be crop residues, pastures or any plant material in the soils of the experimental: site. Bacteria and fungi consume organic matter breaking it down in the process. Bacteria and fungi in turn are consumed by Collembola, mites and subsequently mites and Collembola are eaten up by coleopterans and termites. This is the simplest food web which is visible by the data collected in the experimental period. The population of all the members at different trophic levels is different in all the working sites and also variable as there is a seasonal variations in the microarthropod groups.

The aggregations of microarthropods in these sites are characterized by persistent pattern in organization but continuously changing relative abundance and their composition (Figure 11-18). Each component of the community has a sub sample size of 5-25% of the total microarthropods available in all the sites under investigation. The samples differ with respect to seasonality index of species composition (Table 23-26) but maintained a pattern of 2-4 herbivore sps, 4 saprophore sps and 1-2 carnivore sps. Apart from pure numerical differences, the difference in the season of emergence and abundance of various insects such as high population of Collembola in the monsoon months and also a very high population of family Poduridae in January (Table 7d,e,f-10d,e,f and 11c,d-14c,d). Similarly the larval forms of order Coleoptera, Diptera, Isoptera coincided with a high population of Acarina (Figure 11-18 and 19g,h,i-20g,h,i, 21e,f-22e,f). These Figures shows that timings of abundance for insects, at one site do not necessarily coincide with the occurrence of the same order/family at other sites. Boyd (1960), suggested that such difference in timing of abundance of similar species over different sites might have been caused by-

a) species having distinct periodicity in different habitats,
b) more than one species of the same order when considered simultaneously will have different periodicity.

Evans and Mudroch (1968), Teraguchi and Teraguchi (1977) however, considered that species do have different periodicity in different habitat, as the soil conditions and the climate have a direct effect on the abundance of soil inhabitants. The soil microarthropods mainly complete their life cycles in the soil itself but as we have collected larval forms of (Lepidoptera, Diptera and Coleoptera) whose adult lay their eggs in the soil and larval forms when they available food that is the mites and Collembola. The timing of emergence of larval forms coincides with the thick population of mites and Collembola that is in monsoon months. In the present study, we were unable to collect good amount of fungi from the Mango orchard and unarable land. Therefore, the amount of organic matter was also less (0.75%) and subsequently the population of all the other groups of microarthropods and acari.

Trophic Composition

In a soil food web the minimum requirement of soil microarthropods is sufficient amount of carbon and nutrients, moisture, oxygen and an optimum pH and temperature. The tolerance of pH and temperature may vary among different groups and species. Interestingly, most soil animals occur in the surface layer (up to 5 cm of soil) because this layer contains the most food (carbon and nutrients) in the form of the organic matter and other organisms. Therefore, the organic matter is key constituent in sub soil ecosystem. It is the storehouse for the energy and nutrients used by plants and other organisms. The microarthropods such as bacteria and fungi, and other soil dwellers transform and release nutrients from the organic matter. A significant outcome of the comparative study of the component communities of different habitats is a fair degree of constancy of trophic composition with varying taxonomic composition. This is in accordance with some earlier analyses made by Pinaka (1975), Rosenzeig (1975), Teraguchi and Teraguchi (1977). They hypothesized three implications which can be drawn from predator/herbivore ratio ranging between 0.85-1.3 of trophic composition.

i) that steady state diversities exist;

ii) that trophic species composition is a variable which can be corrected with diversity and hence a restricted number of trophic patterns are more probable than others.

iii) that dispersal may be sensitive to trophic structure of local assemblages.

In the present study all the experimental sites showed almost constant value of species diversity index (H') and a low value of evenness index (J) over different months of the two year study (Table 23-26). This clearly shows the prevalence of the concept of steady state diversity with respect to species composition in these habitats. The present study conducted for a period of two years showed indices like species diversity (H') and species evenness (J) change in a similar manner. These results apparently do not show any result but there is a density difference between number of species and their abundance in all the sites under investigation. Considering all the factors for the abundance of one a group at one particular site or the density of all the microarthropods in all the working sites, it is evident that there exists a balanced sub soil ecosystem with a food chain. The food chain is represented by different trophic levels. We observed a clear prey predator relationship as the mites eat up the collembolans, and collembolans thrive on the fungus, bacteria etc. the soil microarthropod community share the micro environment with other macrofauna such as the nematodes and earthworms in general. Sharing of the vertical and horizontal sub soil space creates a competition among the inhabitants.

The sharing of the same resources i.e. food and space, is calculated in terms of available plant material for herbivores, total number of herbivores for carnivores, and total number of dead herbivores, carnivores and plant material for the detritus feeders or the decomposers the Collembola, Diplura, and Acari. The correlation coefficient between all the trophic levels is significant and linear (Figure 23-30).

The overall role of the microarthropods in a soil food web is that of decomposers. As the organisms decompose complex materials or consume other organisms, nutrients are converted from one form to another, and are made available to plants and to other soil organisms. All plants – grass, trees, shrubs, agricultural crop – depend on the soil food web for their nutrition.

The Importance of Soil Food Webs

The living component of soil, the food web, is complex and has different compositions in different ecosystems. Management of croplands, forestlands, gardens and barren lands benefits from and affects the food webs. Soil microarthropods perform several functions in the soil that make them a vital part of all ecosystems, including agriculture they are involved in

- Degradation of organic matter and mineralization of nutrients. Degradation of organic matter is the central process in the soil. The breakdown of plant nutrients is often accelerated in the presence of soil fauna that is the soil microarthropods (Seastedt 1984). It increases the exposure of substrates to the microflora, leading to enhanced nutrient release (Scheu and Wolters 1991). After decomposition, mineralization of nutrients is also done in a number of ways. The soil microarthropods contribute directly to mineralization when they release mineralized nutrients in their excreta. Indirectly they affect organic matter, decomposition by; grazing on the microbial biomass thus altering the rate at which they break down organic matter, fragmenting organic matter and increasing its surface area for attack by microorganisms, controlling the grazing pressure of nematodes on shredders.

- Controlling populations of pathogens improving and maintaining soil structure, mixing organic matter through the soil. Soil microarthropods along with nematodes and earthworms have an important role in the formation of soil structure. They improve soil structure by forming channels and pores concentrating fine – soil particles together into aggregates. Uncontrolled land management techniques will lead, to decrease in the number of soil microarthropods, (as in wheat field) and also cause soil compaction.

Soil compaction occurs where moist or wet soil aggregates are pressed together and the pore space between them is reduced. Compaction changes soil structure reduces the size and continuity of pores, and increase soil diversity. It also reduces the capacity of the soil to hold water, limits water infiltration resulting in increased runoff and vulnerability to erosion and hence further loss of potential productivity. Therefore, the population of soil microarthropods maintain the structure of the soil by biological tillage that is movement within the substratum, between the pores and channels upto the roots of the plants for proper circulating and mixing of nutrients, water and air.

Hence to conclude that soil microarthropods are a vital link in the food chain as decomposers and without these organisms nature would have no way of recycling organic material on its own (Trombetli and Williams 1999). The process of decomposition is largely controlled by soil microarthropods. They also serve as prey base for small predators, thus sustaining other arthropods. Predation and competition are the main factors controlling the dynamic balance between different groups of organisms with different feeding habits. Predation has an important role because it establishes a balance between the number of individuals and the quantity of available resources. Competition is another way to maintain soil fauna populations in equilibrium with soil resources. Without arthropods in general and microarthropods in particular most terrestrial ecosystems would rapidly collapse.

BIOLOGICAL QUALITY OF SOIL (QBS): A NEW APPROACH

Introduction

Modern agriculture has led to deep changes in the ecosystems and to severe impacts on the environment. Among these impacts reduction in biodiversity and degradation of soil quality are often viewed as major threat for future (Solbrig 1991). Soil quality plays an important role in the assessment of sustainable land use systems. Especially in tropical region, drastic land use changes caused mainly by deforestation have led to increasing soil fertility and to soil erosion (Geissen and Morales 2006). For assessing and maintaining the soil biodiversity the sustainable development programme was introduced by ecologists. This sustainable development principle has focused mainly on the soil health and soil quality. The sustainable use of soil and its management would definitely lead to maintain the soil biodiversity and in turn the soil health.

Biodiversity became the central concept in agronomical research. This summit generated a world wide consciousness of the importance of biodiversity and its protection for sustainable development (Brundtland 1987, Clergue et al 2005). Now the question arose why to protect biodiversity the reasons:

- biodiversity represents a potential resume of new compounds for medicines
- interesting genes for plant breeding and services for agriculture
- it is mankind's heritage and we cannot decide on the existence or not of a species (Cairns 1997)

The soil biodiversity has received less alteration because many still believe that soil is a lifeless substrate, yet it constitutes a complex maze of microhabitat and contains some very important organisms which contribute significantly to maintain life on earth (Lavelle 1996). The relevance of using soil microorganisms to monitor soil ecosystem is due to their role in ecological processes. Studies have shown that soil fauna improve agricultural productivity through their activities on soil (Vikram 1994, Wood 1996, Lee and Foster 1991, Brussard et al 1993, Lavelle et al 1992, Tinzara and Tukahirma 1995, Black and Okwakol 1997, Beare et al 1997).

Sustainable use of soil should be indicated by an ecological indicator. Soil quality and soil health is indicated or evaluated by a number of indicators such as chemical, physical and biological depending upon the scale and the objective of the evaluation. A review of soil quality indicators showed that few of them are largely dominant. e.g. soil organic matter among chemical indicators (Bowman et al 2000, Brejda et al 2000, Gilley et al 2001, Kettler et al 2000, Li et al 2001, Liebig and Doran 1999) bulk density (Gilley et al 2001) and aggregate stability (Bowman et al 2000, Six et al 2000) among physical indicators were the most represented while some authors used biological indicators for soil quality. The biological indicators were mainly the microfauna of the soil.

An indicator should be fulfill the following criteria;

1) sensitivity to various of soil management,
2) helpfulness to reveal ecosystem processes,
3) comprehensibility and utility for land manages,.
4) economy and ease to measure.

The objective of this study was also to assess the soil quality/ecological quality of the soils based on the presence/absence of certain groups of soil mesofauna. The assessment of soil quality is based on the assumption that the abundance of microarthropods indicates the type and intensity of alterations in the soil physical and chemical properties. Invertebrates usually represent good indicators of ecological condition because they are highly diverse and functionally important, can integrate a variety of ecological processes and are sensitive to environmental changes and are easily sampled.

Biological Indicator System for Soil Quality

This was a system developed in Netherlands to assess soil quality based on the ecological status and ecosystem services provided by soil (Brussaard et al. 1997). The system helps in assessing the threat to ecosystem processes by estimating and comparing the number of a species in a functional group with its reference area. The indicator is based on ecological processes and biotic interactions. Five ecosystem services are considered;

- ➢ Decomposition of organic material
- ➢ Nutrient cycling
- ➢ Soil fertility
- ➢ Soil structure
- ➢ Stability of the biotic communities

A range of soil biotic variables are measured to reflect the functions responsible for the above services. These include;

- ❖ the abundance and diversity of microarthropods
- ❖ measure of microbial activity
- ❖ biomass

These biotic characteristics are correlated to the abiotic conditions in the site of measure. The resulting data can be presented in graphical form, as the deviations of each indicator value from the benchmark.

Biological Soil Quality index

The biological soil quality was evaluated by using the Biological Soil Quality index, proposed by Parisi (2001). The BSQ is based on the following concept: the higher is soil quality, the higher will be the numbers of microarthropods groups adapted to the soil habitat. Among edaphic microarthropods morphological characters of their body show the adaptation level to soil environment. The BSQ-i is based on the life-form approach (Sacchi and Testard, 1971) applied to edaphic microarthropods with a double objective of: 1) evaluating the microarthropods adaptation level to soil habitat; 2) overcoming the difficult taxonomic analysis of species. In fact BSQi do not requires of species present in the sample.

BSQ index is applied by separating the organism extracted from soil samples into groups having homogeneous morphological characters. This is done on the base of the Ecomorphological Indexes (EMI) (Parisi, 2001), that allow to associate a score to each microarthropod group and to calculate the BSQ index by adding the score of each group. Two different types of BSQ are proposed, one based on microarthropods (BSQ-ar) and a second one based only on Collembola species (BSQ-c).

Materials and Methods

To assess the soil quality soil health and soil fertility the data collected from the four different sites during the investigation period was used. Soil biological quality index the QBS. Approach based on the biological forms of edaphic microarthropods used to assess soil quality. For the assessment of QBS index of the soil, the soil samples were collected from the four sites when the soil was wet and not after heavy rains. Taking apart the upper plant cover and sampling as separate samples of the litter, a 10x10cm area is dug up to 10cm depth. A square soil cover is used in areas were tree roots are present (Teak plantation and Mango orchard). The samples are posed in a plastic bag labeled and closed before taking it away from light and heat of the surrounding area.

Soil samples from the very particulars area are also collected for physical and chemical analysis at that time period. Soil samples were taken to lab protected by thermal shock and soil fauna has to be extracted within 48 hours from sampling. The soil corers were delicately placed on the mesh of the Tullgren funnel apparatus. All the soil fallen during sample disposal is put again on the mesh before inserting a bottle of preservative liquid (2 parts ethanol 75% and 1 part glycerol) beneath the funnel. Extraction during (never less than 5 days) will be proportionate to water content in the sample, as determined by appropriate falling curve (Parisi 1974, Gorny and Grum 1993). The extraction period will be shorter or less than 5 days for litter samples.

Specimens setting

Extracted specimens are observed under a stereomicroscope at low magnification (range 5-100x; usually 20-40 x are sufficient) in the same preservative liquid, pouring the animals and the liquid in Petri dishes or similar. Whenever it might be useful to render collembolans more transparent for taxonomic identification, they are put in Gisin (1960) liquid: lactic acid, glycerol, 40%formic aldehyde, in 10:2:0.4 proportions.

Observations and Results

Biological forms – eco-morphologically homogeneous groups - are therefore separated, and their respective Eco-Morphologic Indexes (EMIs) are reckoned, as shown in table 2 (Parisi, 2001). Two different types of QBS Index were proposed, one based on total microarthropods ("QBS-ar") and a second one based only on Collembola species ("QBS-c") (Parisi, 2001; Gardi et al 2002). For QBS-ar calculation, the EMI values associated to each microarthropods group are reported in table 2. EMIs allow associating a value to each microarthropod group, according to its soil adaptation characteristics. As a general rule, **eu-edaphic** (i.e., deep soil-living) forms get an EMI=20, **hemi-edaphic** (i.e., intermediate) forms achieve a count proportionate to their degree of specialization, **epi-edaphic** (surface-living) forms score EMI=1. Some groups obtain a single EMI value: e.g. for Protura and Diplura EMI=20, because all species belonging to these groups are eu-edaphic. Other groups display a range of EMI values (e.g., for Collembola and Coleoptera, EMI=1-20), because these groups have species with different soil adaptation levels. Whenever two eco-morphological forms are present for a same group, the final score is decided by the higher EMI. In other words, the most adapted degree of specialization to soil life shown by specimens belonging to a group determines the overall EMI score for that group.

To calculate the QBS score of a sample, it is sufficient to sum up the EMIs of all groups collected there. Acari get a unique score, EMI=20, because it is almost impossible to get a soil sample without them, and owing to the difficulties to outline easy-to detect eco-morphological characteristics. Collembola are also among the most abundant soil microarthropods, and have shown to be very sensitive to variations in soil environment. Moreover, they show a good variety of morphological features that are easier to detect and to assess.

Table 1 - Soil Biota Knowledge (from Brussart et al 1997)

Micro-organisms	**Described Soil Species**	**Global Biogeographical**
Synthesis		
Bacteria & Archaea	3 200 (1)	no
Fungi	18 - 35 000	no
AM Fungi	200	no
Ectomichorryzal Fungi	10 000	no
Microfauna		
Protozoa	1 500	no
Ciliates	400	no
Nematoda	5 000	no
Mesofauna		
Acari	ca 30 000	no
Collembola	6 500	yes
Enchytraeids	> 600	no
Macrofauna		
Root herbivorous insects	ca 40 000	no
Termites	2 000	yes
Ants	8 800	yes
Earthworms	3 627	yes

(1) total number; soil fraction unknown

Table 2 – Eco-morphological Indices (EMIs)
(Scores to calculate QBS-ar. Parisi, 2001)

Group	Score
Protura	20
Diplura	20
Collembola	1-20
Isoptera	1-20
Psocoptera	1
Homoptera	1-10
Thysanoptera	1
Coleoptera	1-20
Hymenoptera	1-5
Diptera (larvae)	10
Other holometabolous insects **(larvae)** **(adults)**	10 1
Acari	20

Notes to table 2

Some taxonomic groups get only a single EMI value, while others include a range. The former groups reach values that are considered the maximum representative scores given to the eu-edaphic adaptation levels for those taxa. In the latter case, it was not considered correct to attribute a single value of EMI, due to the variety of characters present within the group. Apart from Collembola, which can be ranked according to a specific EMI determination (Table 3), other non-single value groups get their correct score according to the following rules:

Coleoptera	clearly epigeous forms	point 1
	Main adaptations to underground life that can be detected by direct examination of specimens are: a) dimensions smaller than 2 mm b) thin integument, often testaceous (tan-brown) colour c) hind wings highly reduced or absent d) microphtalmy or anophtalmy For these forms, the EMI value is equal to the sum of points relative to the detected characters -e.g. if only a) and b) are present, then EMI score is = 1 + 4 + 5 = 10)	 points 4 points 5 points 5 points 5
Hymenoptera	In general	points 1
	Formicidae	points 5

Table 3 – A Simplified Scheme to Calculate Collembolan's EMI (from Parisi, 2001)

Character	EMI Score
1) Clearly epigeous forms: middle to large size, complex pigmentation present, long, well-developed appendages, well developed visual apparatus (eye spot and eyes)	1
2) Epigeous forms not related with grass, shrubs or trees well-developed appendages, (possible) well-developed setae or protective cover of scales, well-developed visual apparatus	2
3) Small size -though not necessarily- forms, usually limited to litter, with modest pigmentation, average length of appendages, developed visual apparatus	4
4) Hemi-edaphic forms with visual apparatus still developed, not elongated appendages, cuticle with pigmentation	6
5) Hemi-edaphic forms with reduced number of ommatidia, scarcely developed ppendages, often short or absent furca, pigmentation present	8
6) Eu-edaphic forms with no pigmentation, reduction or absence of ommatidia, furca present - but reduced	10
7) Clearly eu-edaphic forms: no pigmentation, absent furca, short appendages, presence of typical structures such as pseudo-oculi, developed postantennal organs (character not necessarily present), apomorphic sensorial structures	20

Table 4: EMI Calculation for Collembola (from Parisi, 2001)

Characters	**EMI score**
Size	
big >3 mm	0
intermediate 2-3 mm	2
small < 2 mm	4
Pigmentation	
complex (e.g. *Orchesella, Seira*)	0
simple (e.g. *Isotomurus, Tomocerus*)	1
uniform (or limited to appendages, distally)	3
absent	6
Fanera and other integument structures	
great development of macro-chaetes &/or scales, presence of trichobotria	0
modest cover of fanera	1
topographic specialization and reduced number of chaetes, particular sensilla on antennas, Post Antennal Organ present, AD present (not all these characters may be present)	3
scarce chaetes, sensors and particular structures present in various body parts	6
Anophtalmy	
8+8 ommatidia	0
6+6 ommatidia	2
from 5+5 to 1+1	3
no ommatidia	6
Antennas	
antennas much longer than head diagonal	0
ca. same length	2
shorter antennas	3
much shorter (often with particular sensilla)	6
Legs	
well developed	0
intermediate	2
short	3
reduced or with lacking/reduced empodium, nail often without denticulation	6
Furca	
well developed	0
intermediate	2
short with reduced number of setae	3
lacking mucron &/or alterations in manubria and teeth forms	5
Loss of furca or its reduction to a rudiment	6

Table 5: Numbers of individuals (nm^{-2}), eco-morphological value (EMI) for the QBS-ar index calculation, QBS-ar index and Acari/Collembola ratio

Order	Form	Mango Orchards				Teak Plantation				Unarable Land				Wheat Field			
		2008-09		2009-10		2008-09		2009-10		2008-09		2009-10		2008-09		2009-10	
		nm^{-2}	EMI	nm^{-2}	EMI	nm^{-2}	EMI	nm^{-2}	EMI	nm^{-2}	EMI	nm^{-2}	EMI	nm^{-2}	EMI	nm^{-2}	EMI
Diptera	Adult	238	10	501		342		445		169		534		229		703	
	Larvae	3	1			2		10		151		18		144		178	
Coleoptera	Adult	64	10	81	10	83	10	70	10	44	5	103	10	119	20	241	20
	Larvae	29	5	144	10	73	5	107	10	33	5	376	20	49	5	52	5
Hymenoptera	Adult	54	1	18	1	121	5	454	10	218	5	323	5	125	5	31	1
	Larvae									1		2		1		1	
Thysanoptera	Adult	20	1	39	1	25	1	43	1	12	1	17	1	10	1	31	1
	Larvae																
Homoptera	Adult													27	1	13	1
	Larvae																
Isoptera	Adult	146	20	193	20	107	20	149	20	450	20	627	20	98	20	82	20
	Larvae																
Pscoptera	Adult			3	1	1	0	2	0	2	1			1	0		
	Larvae																
Lepidoptera	Adult																
	Larvae	8	5	5	5	121	5	28	5	286	5	262	5	137	5	120	5
Collembola		576	20	2188	20	452	20	810	20	1255	20	929	20	107	20	366	20
Diplura		17	10	30	10	27	10	28	10					15	5	38	10
Acarina		571	20	1848	20	484	20	1724	20	588	20	1626	20	227	20	110	20
QBS-ar			103		98		96		106		82		101		102		85

Discussion

The term soil quality means the capability of a specific type of soil to function, within managed or natural system boundaries, to be able to sustain biological productivity, enhance or maintain air and water quality as well as support human habitation and health (Karlen et al 1997). The soil health is most preferred because most of us believe soil as a living entity with a dynamic system. The soil health is maintained by its biological diversity. There in this chapter we have tried to assess the soil quality by using the biological indicator as a tool. The indicators are useful tools for monitoring soil biodiversity and soil health.

As evident from the Table 5, the QBS-ar and QBS-c in all the four sites is highly variable, because of the fact that the sites are different in their vegetation type and land use. The QBS-ar in Mango Orchard, Teak Plantation, Unarable Land and in Wheat Field was approximately same in 2009 and in 2010. The Acarii/Collembola ratio 18.69: 17.40 a review of the scientific literature shows that the microarthropods are sensitive to almost all soil pollutants or disturbances, although there are sometimes large differences between the groups and, in many cases, also within groups (Van Straalen 2004). In this study microarthropods were evaluated in four different sites, mango orchard, teak plantation, wheat field and an unarable land. The microarthropods population from all the four sites belonged to order Diptera, Coleoptera, Hymenoptera, Thysanoptera, Homoptera, Isoptera, Pscoptera and Lepidoptera both adult and larval forms of Pterygote group. The Apterygote insects comprised of order Collembola, and Diplura only. Acarina was also collected in good number from all the sites. Representatives of order – Homoptera were present only in wheat field and that too in very small number. Pscopterans though present in all the four sites but negligible in number. Lepidopterans were represented by of course only larval forms. The diversity of microarthropods in all the four experimental sites suggest that the soil quality is good, because the population of all the different groups when compared with the edaphic abiotic factors should a direct relationship between them. As the microarthropods have a good number when the soil moisture is high (4.28%) along with low soil temperature and low atmospheric temperature and humidity. The population of acarina was high throughout the period in almost all the sites, especially high in unarable land and also high in plantation area. Therefore the acarii/Collembola ratio is also 18.69: 17.40 gives as an indication that the soil is healthy and fertile.

The presence and absence of all the soil microarthropods in the soil samples are dependent to several local variables and need statistical studies to be carefully assessed. The QBS-ar index is based on a concept that there is a direct correlation between the quality of the soil and the number of microarthropods well adapted to the soil habitat. Hence the QBS-ar index from all the four sites falls in line with the workers (Parisi 2001).

Conclusion

The QBS/BSQ indicator is based on ecological processes and biotic interactions. Five ecosystem services are considered:

- Decomposition
- Nutrient cycling
- Soil fertility
- Soil structure
- Stability of the biotic communities

The ecological indicators have a two-fold main function: to decrease the number of measures and parameters and to simplify the communication process through which the collected information to send to the final user. Compared with methods that use a single taxon as biological indicator, QBS does not require a species level diagnosis and is therefore considered an appropriate tool for large scale monitoring. The QBS approach – a fast characterization of edaphic populations from a sampling station, shows its applicability that allow affordable and effective soil microarthropod extraction at low costs. The informations pertaining to soil health and fertility can be easily estimated and can be passed on to the users and policy makers. The soil quality assessed on the QBS-ar index shows that the soil in all the four sites is healthy and good quality and fertile enough as it is an abode for so many microarthropods.

Conclusion

CONCLUSION

Most soil organisms live in a variety of symbiotic relationships. Symbiotic relationships include; mutualism; commensalism; competition; parasitism and predation. These relationships allow many diverse organisms to line in conditions that they could live in on their own. Together they create substances and recycle materials that create the conditions necessary for life in soil. Some soil microarthropods have a definite relationship with each other hence they form the key indicator group. The soil microarthropods along with soils macrofauna take part in the process of soil formation or in a way maintaining soils health. Therefore, a soil with higher diversity is more likely to function than a poorer soil because: (i) it is a guarantee that all the activities necessary to soil function will be realized; (ii) soil should be able to better resist to external aggressions (natural or human induced); (iii) diversity is also related to the existence of a balance between animals through predation and competition that can protect soil from harmful effects of pests.

Soil which is the most precious resource for mankind should be protected and maintained to its maximum. For this, the soil should apart from its physical characters such as texture, porosity, colour, amount of sand and silt present in the soil, the chemical characters such as the pH, the moisture content, the presence of organic matter and micronutrients such as phosphate, nitrate, carbonate, potash etc of the soil should be taken care of. When these physical and chemical factors will be in equilibrium, the biological factors, the biodiversity will be maintained, because for the health and fertility of the soil, the biodiversity is the most essential component. Various macro and microclimatic changes (temperature, photoperiod, rainfall, humidity, decomposition) and variation in the availability of food resources are the important factors in triggering seasonal activity of insects.

In the present investigation we tried to study the faunal composition of the soil, their, seasonal fluctuation in the population, and role of edaphic factors on their population dynamics. It is evident from our observations that the intricate relationship between edaphic invertebrates and their ecological niches in the soil, the fact that many of them live a rather sedentary life and the stability of community composition at a specific site provide good starting point for bioindication of changes in soil properties and the impact of human activity.

Their value as bioindicators for environmental monitoring and conservation purposes has long been investigated, we tried to analyse the health of the soil at all the four sites with the help of the BSQ index. It appeared to us that the more diverse the composition of the soil fauna the more healthy and fertile is the soil. Therefore, the role of soil microarthropods as a major part of the decomposer community in the sub soil ecosystem is very important. The activities of soil microarthropods interact in a complex food web. The soil food web is a way to relate soil organisms to one another on the basis of what they eat. Some of these organisms feed on living plants (herbivores) and animals (predators), some on dead plant debris (detritivors), some on fungi or bacteria, and others live off, but without consuming, their host (parasites). Plants, mosses and some algae are autotrophs, and they act as primary producers by using solar energy, water and carbon from atmospheric CO_2 to make organic compounds and living tissues. Soil microarthropods and most fungi rely on organic materials directly. All terrestrial ecosystems, including agricultural production systems, consist of a producer subsystem, and a decomposer subsystem, and both components depend upon each other.

A biologically healthy soil harbours a multitude of different organisms – microorganisms such as bacteria, fungi, amoeba, as well as microarthropods including Collembola, Diplura, mites, Pterygote adult and larval forms, termites, ants and beetles. Most are helpful to plants enhancing availability of nutrients and producing chemicals that stimulate plant growth. A healthy soil produces healthy crops with minimum external input.

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